MANUAL CHANGES

MODEL 3400A

RMS VOLTMETER

Manual Serial Prefixed: 401-
-hp- Part No. 3400A-902

To adapt this manual to instruments with other serial prefixes check for errata below, and make changes shown in tables.

► New or Revised Item.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
ALL	ERRATA		
401-02126 and above	Change 1		
528-	Change 1, 2		

ERRATA:

► Table 1-1, Specifications:

1. Change Table 1-1 according to the information given below:
   CREST FACTOR: 10 to 1 at full scale, except where limited by maximum input, inversely. . .
   MAXIMUM INPUT: 1000 v peak.
   OVERLOAD: With 10 to 1 crest factor, 30 db or 1000 v peak, whichever is less on each range.

Operating Instructions, Section III:

► 1. Insert between Paragraphs 3-7 and 3-8 the following caution:

CAUTION

DO NOT MEASURE SIGNAL ABOVE 100 VOLTS WITH 10 TO 1 CREST FACTOR. OTHERWISE, THE MAXIMUM INPUT RATING (1000 VOLTS PEAK) WILL BE EXCEEDED. WHEN MEASURING SIGNALS UP TO 100 VOLTS RMS WITH A 10 TO 1 CREST FACTOR, USE THE BNC TO DUAL BANANA JACK, ACCESSORY 10110A, SUPPLIED WITH THE INSTRUMENT, OR OTHER INPUT TEST LEADS AND CONNECTIONS THAT WILL WITHSTAND THE MAXIMUM INPUT OF 1000 VOLTS PEAK.

2. Insert between steps b and c of Paragraph 3-8 the following caution:

CAUTION

WHEN MEASURING AN AC SIGNAL SUPERIMPOSED ON A DC LEVEL, ALWAYS SET THE RANGE SWITCH TO THE 300 VOLT POSITION BEFORE MAKING THE INITIAL CONNECTION TO A CIRCUIT SINCE A HIGH VOLTAGE TRANSIENT DUE TO THE APPLICATION OF A DC VOLTAGE WILL DAMAGE THE INPUT CIRCUITRY.

Paragraph 3-15:

1. Change title to read: RMS AC-TO-DC CONVERTER.

► Paragraph 4-31:

1. Change the third sentence to read: Diodes CR602 and CR603 are biasing diodes for Q602 and Q603 respectively.

Paragraph 5-10:

1. Change step d to read: Adjust oscillator output frequency for 400 cps; adjust oscillator output amplitude for full-scale deflection on the Model 3400A.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
ALL	ERRATA		
401-02126 and above	Change 1		
528-	Change 1, 2		

ERRATA (Cont'd):

► Table 5-6, Troubleshooting Procedure:

1. Change the voltage in check (8), step a, second sentence, to read: -1.0 v (-0.15 v for 1/10 scale deflection).
2. Change check (9) to read: Measure ac signal to Second Attenuator to negative end of C205. Reading should be between 90 mv and 100 mv.
3. Change figures in Table 5-6 according to the following:
   Figure 5-6, Vert = 0.5 volts/cm.
   Figure 5-9, Vert = 2 volts/cm.
   Figures 5-10 and 5-11, invert the waveform.

   NOTE

   Waveforms shown in Section V are typical and may vary in amplitude and/or width from instrument to instrument.

Figure 6-2, Video Amplifier A4 Schematic:

1. Connect the base of Q403 to junction of R401 and R431 and remove the connection between the emitter of Q402 and the base of Q403.
2. ► Change voltage on base of Q401 to -0.79.

► Figure 6-3, Chopper Amplifier A6 Schematic:

1. Change the voltage at the base of Q604 and Q605:
   Q604, FS $\cong$ -1.0
   1/10 S $\cong$ -0.15
   Q605, FS $\cong$ -1.6
   1/10 S $\cong$ -0.75
2. Change R8 on the 1/10 SCALE ADJ divider to 430* ohms.

Figure 6-4, Power Supply A7 Schematic:

1. Change voltage on CR715 to 17.8 v breakdown.

Tables 7-1 and 7-2:

1. Transpose the description of CR701 and CR702 with the description of CR715.
2. Change description of Q604 to read: Transistor: Si, 2N3391, NPN.
3. ► Change description of Q605 to read: Transistor: Si, 2N3638, PNP.
4. ► Add asterisk to R8.
5. ► Change A5 Part No. to read: 1990-0017.
6. ► Add to description of A5:

   NOTE

   Matched neon subassembly (DS501 and DS502) available under -hp- Part No. 5082-5168.
7. ► Change C428 thru C602 to:
   C428 thru C600 and add: C601, -hp- Part No. 0180-0081, C: fxd, elect, Ta, 50 μf +20% -15%, 10 vdcw.
   C602, -hp- Part No. 0180-0064, C: fxd, elect, 35 μf +100% -10%, 6 vdcw.

► CHANGE 1:

Tables 7-1 and 7-2:

1. Change Part No. and description of Q405 to read: 1853-0009, Transistor: Si PNP.
2. Change Part No. and description of CR401 to read: 1901-0025, Diode: Si, 100 piv.
3. Change Part No. and description of CR715 to read: 1902-3223, Diode: Si, breakdown, 17.4 ±2% 400 mw.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
ALL	ERRATA		
401-02126 and above	Change 1		
528-	Change 1, 2		

► CHANGE 2:

Table 1-1, Specifications:

1. Change Table 1-1 according to the information given below:
   POWER: 115 or 230 v ±10%, 50 to 1000 cps, ...

Figure 6-4, Power Supply A7:

1. Replace Figure 6-4 with Figures B and C in this change sheet.

Tables 7-1 and 7-2:

1. Change R701 and R702 to read: 0687-5631, R: fxd comp 56 K.
2. Add the following components:

Ref. Des.	-hp- Part No.	Description
R715	0687-2241	R: fxd comp 220 K ±10% 1/2 w
R713	0686-2225	R: fxd comp 2.2 K ±5% 1/2 w
Q706	1854-0022	Transistor: Si NPN
CR718	1902-0046	Diode: breakdown 7.15 v ±10% 400 mw
CR719	1901-0028	Diode: Si 400 piv
C711	0160-0167	C: fxd 0.082 μf ±10%
C712	0180-0282	C: fxd Al elect 35 μf +75% -10% 250 vdcw

Section V, Maintenance:

1. Figures 5-12 and 5-13 no longer apply.
2. Figure A of this change sheet illustrates a proper neon voltage waveform observed across either pin 3 or 5 on the A6 assembly and chassis ground.

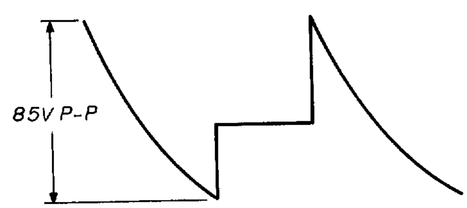

Figure A

Section IV, Theory of Operation:

1. Any reference in Section IV to the neon lamps being driven by line voltage and/or at line frequency should be changed to concur with the paragraph added below:

   4-48. NEON LAMP DRIVE OSCILLATOR.

   4-49. The neon lamp drive oscillator consists of transistor Q706, diode CR718, resistors R701, R702, R712, R713, and capacitor C711. Transistor Q706 is held on (conducting) by the base bias developed at the junction of R712 and CR718. The collector current of Q706 charges up capacitor C711 through R701 or R702 depending upon the illuminated neon lamp on the Chopper Amplifier Assembly A6. When the capacitor reaches a sufficient charge to fire the dark neon lamp, the illumination of the neon lamps alternate and the capacitor discharges through the previously dark neon lamp. With the previously dark neon lamp illuminated, the capacitor charges up in the opposite direction until firing the previously illuminated neon lamp. The cycle described above repeats at a frequency of 90 to 100 cps as determined by the RC time constant of R701, C711, and R702, and C711.

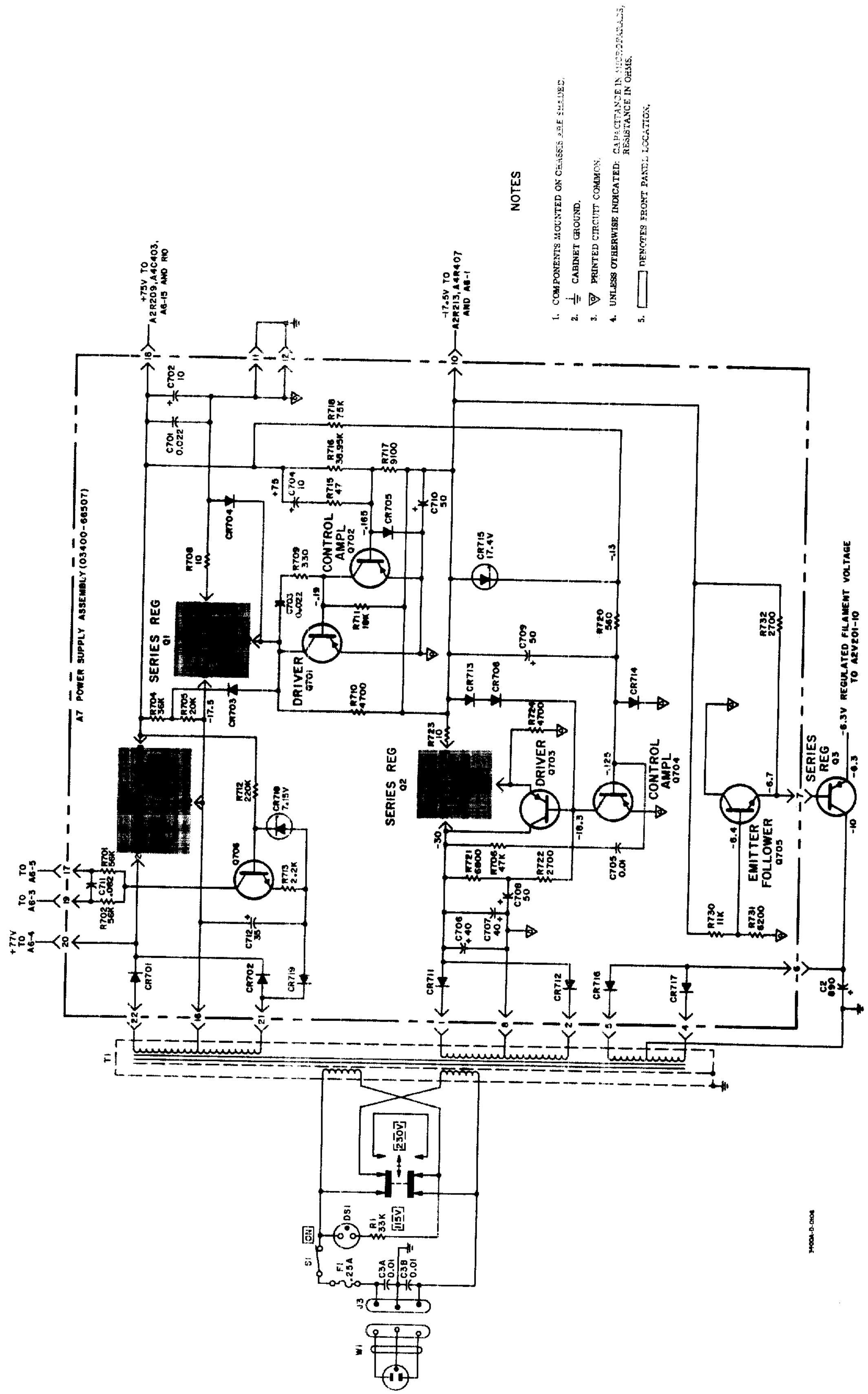

Figure B. Power Supply A7 Schematic

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
ALL	ERRATA		
401-02126 and above	Change 1		
528-	Change 1, 2		

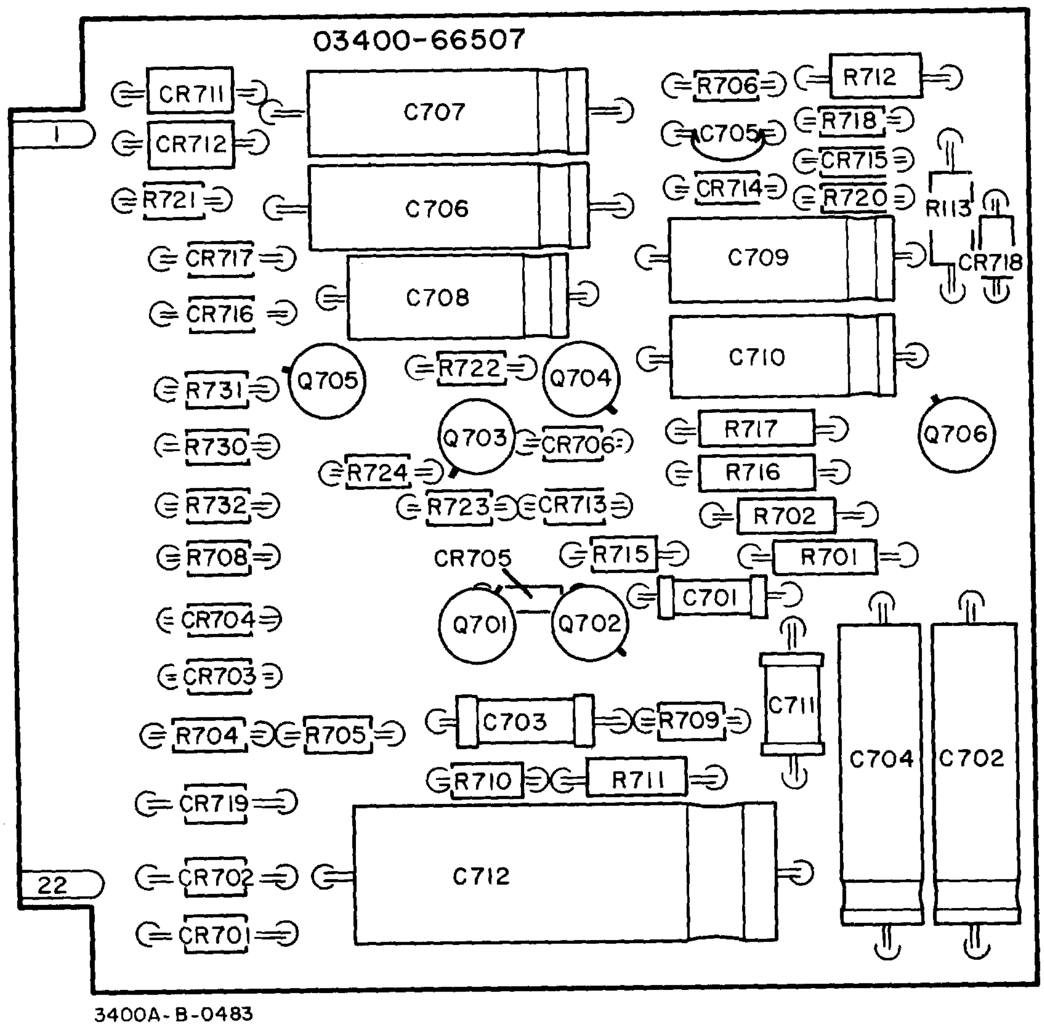

Figure C. Power Supply A7 Parts Location

ERRATA:

Figure 6-3, Schematic:

1. Delete Part No. 5082-5001 for the modulator assembly A5.

CERTIFICATION

THE HEWLETT-PACKARD COMPANY CERTIFIES THAT THIS INSTRUMENT WAS THOROUGHLY TESTED AND INSPECTED AND FOUND TO MEET ITS PUBLISHED SPECIFICATIONS WHEN IT WAS SHIPPED FROM THE FACTORY.

hp FURTHER CERTIFIES THAT ITS CALIBRATION MEASUREMENTS ARE TRACEABLE TO THE NATIONAL BUREAU OF STANDARDS TO THE EXTENT ALLOWED BY THE BUREAU'S CALIBRATION FACILITY.

WARRANTY

All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products (except tubes) which prove to be defective during the warranty period. We are not liable for consequential damages.

For assistance of any kind, including help with instruments under warranty, contact your nearest Hewlett-Packard field office for instructions. Give full details of the difficulty and include the instrument model and serial numbers. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, *except transportation charges*. Estimates of charges for non-warranty or other service work will always be supplied, if requested, before work begins.

CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

SHIPPING

On receipt of shipping instructions, forward the instrument prepaid to the destination indicated. You may use the original shipping carton or any strong container. Wrap the instrument in heavy paper or a plastic bag and surround it with three or four inches of shock-absorbing material to cushion it firmly and prevent movement inside the container.

GENERAL

Your nearest Hewlett-Packard field office is ready to assist you in any situation, and you are always welcome to get directly in touch with Hewlett-Packard service departments:

CUSTOMER SERVICE
Hewlett-Packard Company
395 Page Mill Road
Palo Alto, California, 94306
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Telephone: (415) 326-3950
TWX No. (415) 492–9363
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OR (In Western Europe)
Hewlett-Packard S.A.
54 Route Des Acacias
Geneva, Switzerland
Telephone: (022) 42. 81. 50
Cable: "HEWPACKSA"

3400A

HEWLETT-PACKARD COMPANY / OPERATING AND SERVICE MANUAL

3400A
RMS VOLTMETER

OPERATING AND SERVICE MANUAL

(PART NO. 3400A-902)

MODEL 3400A
RMS VOLTMETER

SERIALS PREFIXED: 401-

Appendix C, Manual Backdating Changes, adapts manual to serials below 401-01826 and serials prefixed 322-.

01768-1

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Printed: JAN 1965

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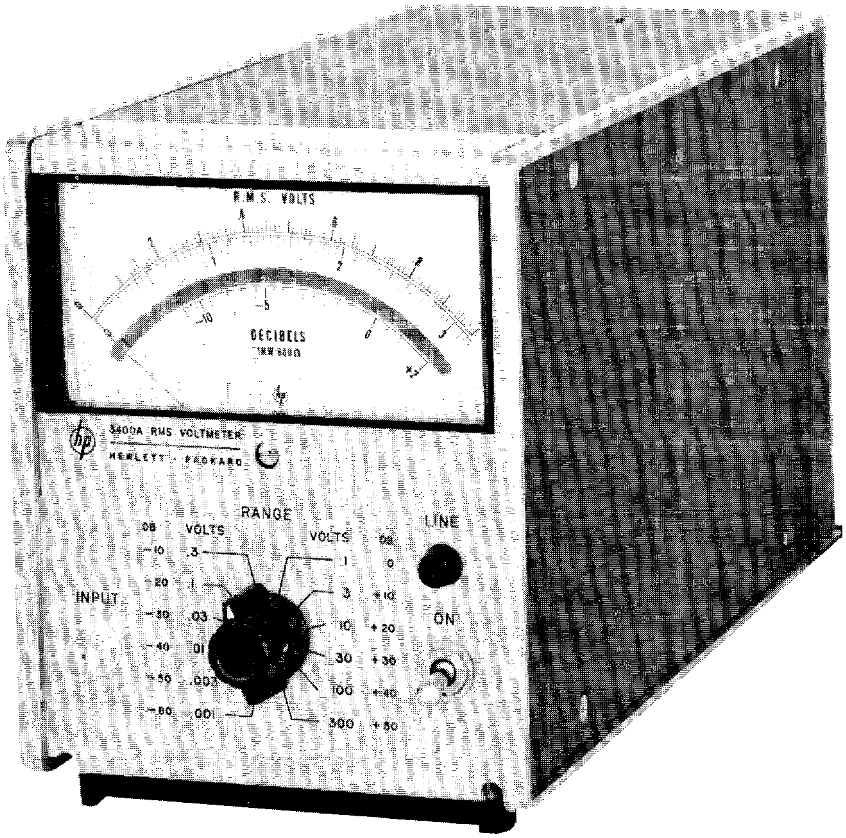


Figure 1-1. ⓗⓟ Model 3400A RMS Voltmeter

Table 1-1. Model 3400A Specifications

RANGE: 12 full scale ranges from 1 mv to 300 v in a 1, 3, 10 sequence. -72 to +52 dbm. (Usable indications to 100 μv.)

METER SCALES: Voltage, 0.1 to 1 and 0.3 to 3. Decibel, -12 to +2 dbm (0 dbm = 1 mw, 600 ohms). Scales are individually calibrated to the meter movement.

FREQUENCY RANGE: 10 cps to 10 Mc.

ACCURACY: Within ±1% of full scale, 50 cps to 1 Mc. Within ±2% of full scale from 1 to 2 Mc. Within ±3% of full scale, 2 to 3 Mc. Within ±5% of full scale, from 10 to 50 cps and from 3 to 10 Mc. (Usable readings to 5 cps and 20 Mc.)

RESPONSE: Responds to rms value (heating value) of the input signal for all waveforms.

CREST FACTOR: (ratio of peak amplitude to rms amplitude): 10 to 1 at full scale, inversely proportional to pointer deflection, e.g. 20 to 1 at half-scale, 100 to 1 at tenth-scale.

MAXIMUM INPUT: 425 v rms.

INPUT IMPEDANCE: From 0.001 v to 0.3 v Range: 10 megohms shunted by 40 pf. From 1.0 v to 300 v Range: 10 megohms shunted by 15 pf.

RESPONSE TIME: Typically <2 sec. to within 1% of final value for a step change.

OVERLOAD PROTECTION: 40 db or 425 v rms, whichever is less, on each range.

OUTPUT: Negative 1 vdc at full scale deflection, proportional to pointer deflection (from 10 - 100% at full scale). 1 ma maximum. Nominal source impedance is 1000 ohms.

POWER: 115 or 230 v ±10%, 50 to 60 cps, approximately 7 watts.

DIMENSIONS: 5-1/8 in. wide, 6-1/2 in. high, 11 in. deep (1/3 module). (130 x 165 x 279 mm).

WEIGHT: Net, 7-1/4 lbs. (3,3 kg) Shipping, 11 lbs. (5 kg).

SCOPE

This manual contains the information necessary for operating and servicing the standard Model 3400A RMS Voltmeter and the Model 3400A/Option 01 RMS Voltmeter (DB scale uppermost).

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section contains general information about the Model 3400A RMS Voltmeter (Figure 1-1). Included are discussions of the description and purpose, instrument identification, equipment supplied, and accessory equipment available. Also included is a table of instrument specifications.

1-3. DESCRIPTION AND PURPOSE.

1-4. The Model 3400A RMS Voltmeter measures the actual root-means-square (RMS) value of ac voltages between 100 microvolts and 300 volts. Frequency range is from 10 cps to 10 Mc. Full scale measurements of nonsinusoidal waveforms with crest factors (ratio of peak voltage to rms voltage) of 10 can be made.

1-5. Ac voltages are measured with a specified full-scale accuracy of ±1% from 50 cps to 1 Mc,±2% from 1 Mc to 2 Mc,±3% from 2 Mc to 3 Mc, and ±5% from 10 cps to 50 cps and 3 Mc to 10 Mc. A single front panel control selects one of 12 voltage or decibel ranges.

1-6. The Model 3400A crest factor rating is 10:1 which enables full scale readings for pulses which have a 1% duty cycle. At 1/10th of full scale, pulse trains with 0.01% duty cycle (100:1 crest factor) can be accurately measured.

1-7. The Model 3400A provides a dc output which is proportional to the front panel meter reading. By using this voltage to drive auxiliary equipment, the Model 3400A functions as an rms ac-to-dc converter.

1-8. SPECIFICATION.

1-9. Table 1-1 contains the specifications for the Model 3400A.

1-10. INSTRUMENT IDENTIFICATION.

1-11. Hewlett-Packard uses a two-section eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 3400A described in this manual.

1-12. EQUIPMENT SUPPLIED.

1-13. The equipment supplied with each Model 3400A is listed and described in Table 1-2.

Table 1-2. Equipment Supplied

IDENTIFICATION NUMBER	QUANTITY	DESCRIPTION
10110A	1	Adapter (BNC to dual banana jack)
8120-0078	1	Power Cord
3400A-902	1	Operating and Service Manual

1-14. ACCESSORY EQUIPMENT AVAILABLE.

1-15. The accessory equipment available is listed in Table 1-3. For further information contact your local ⓗ Sales and Service Office. (See Appendix B for office locations.)

Table 1-3. Accessory Equipment Available

IDENTIFICATION NUMBER	DESCRIPTION
10503A	Cable (Male BNC to male BNC, 48 inches)
11001A	Cable (Male BNC to dual banana plug, 45 inches)
11002A	Test Lead (dual banana plug to alligator clips, 60 inches)
11003A	Test Lead (dual banana plug to probe and alligator clip, 60 inches)

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for installation and shipping of the ⓗ Model 3400A RMS Voltmeter. Included are initial inspection procedures, power requirements, installation information, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. The ⓗ Model 3400A RMS Voltmeter received a careful mechanical and electrical inspection before shipment. As soon as the Model 3400A is received, verify that the contents are intact and as ordered. Although the instrument should be free of mars and scratches and in perfect electrical condition, it should be inspected for any physical damge which may have been incurred in transit. Also test the electrical performance of the instrument using the procedures given in paragraph 5-5 . If any physical damage or electrical deficiency is found, refer to the warranty on the inside rear cover of this manual. Should shipping of the instrument become necessary, refer to paragraph 2-14 for repackaging and shipping instructions.

2-5. POWER REQUIREMENTS.

2-6. The Model 3400A can be operated from any ac source of 115- or 230-volts (±10%), at 50 to 60 cycles. With the instrument disconnected from the ac power source, move the slide switch (located on the rear panel) until the desired line voltage value appears. The ac line fuse is a 0.25 amp, fast blow type for 115- or 230-volt operation. Power dissipation is approximately 7 watts.

2-7. The Model 3400A is equipped with a three-prong power cord. To protect operating personnel, it is necessary to preserve the grounding feature of this plug when using a two contact ac outlet. Use a three-prong to two-prong adapter and connect the green pigtail lead on the adapter to ground.

2-8. INSTALLATION.

2-9. The Model 3400A is a submodular unit suitable for bench top use. However, when used in combination with other submodular units it can be bench and/or rack mounted. The ⓗ combining case and adapter frame are designed for this purpose.

2-10. COMBINING CASE (ⓗ Models 1051A or 1052A).

2-11. The combining case is a full-module unit which accepts various combinations of submodular units. Being a full-module unit, it can be bench or rack mounted and is analogous to any full-module instrument.

2-12. ADAPTER FRAME (ⓗ Part No. 5060-0797).

2-13. The adapter frame is a rack frame that accepts any combination of submodular units. It can be rack mounted only. For additional information, address inquiries to your ⓗ Sales and Service Office. (See Appendix B for office location.)

2-14. REPACKAGING FOR SHIPMENT.

2-15. The following paragraphs contain a general guide for repackaging for shipment. Refer to paragraph 2-16 if the original container is to be used; 2-17 if it is not. If you have any questions, contact your local ⓗ Sales and Service Office.

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicate the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number, and serial number prefix.

2-16. If original container is to be used, proceed as follows:

a. Place instrument in original container if available. If original container is not available, one can be purchased from your nearest ⓗ Sales and Service Office.

b. Ensure that the container is well sealed with strong tape or metal bands.

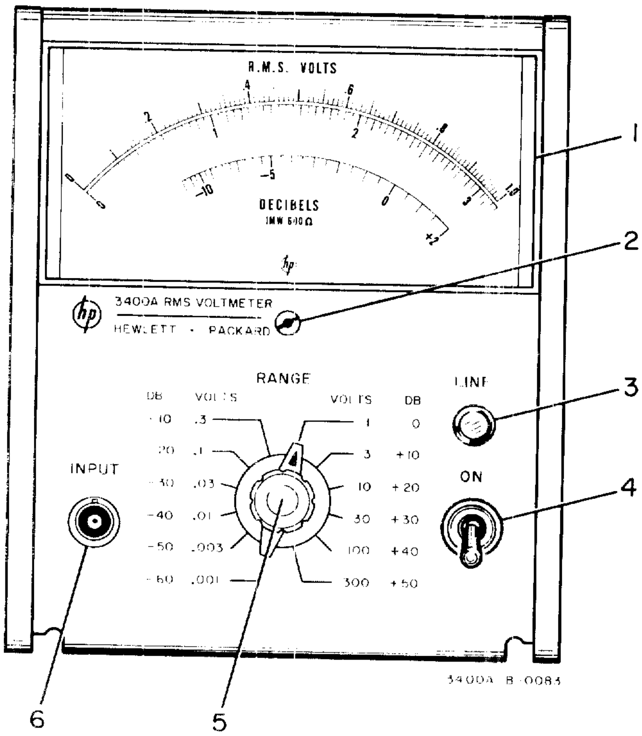
2-17. If original container is not to be used, proceed as follows:

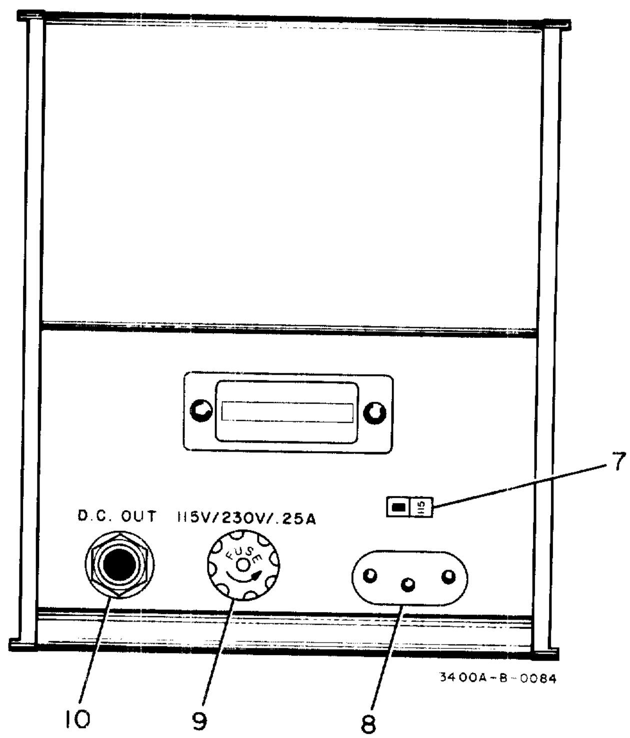
a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Use packing material around all sides of instrument and protect panel face with cardboard strips.

c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE," etc.





1. Direct reading meter: dc meter which indicates rms voltage level of input signal.
2. Mechanical zero adjustment: screwdriver adjustment for zero of direct reading meter.
3. LINE ON pilot lamp: neon lamp which indicates when power is applied to instrument and power switch is ON.
4. Power switch: two-position toggle switch which applies 115- or 230-volts ac to instrument.
5. RANGE switch: 12-position rotary switch which selects various attenuation ranges available within Model 3400A.
6. INPUT connector: BNC jack which enables application of input signal to instruments measuring circuits.
7. 115/230-volt switch: two-position slide switch which sets instrument to operate from either a 115- or 230-volt ac source.
8. Input power jack: three-prong jack which enables application of line voltage to instruments power supply circuits.
9. 115V/230V/.25A FUSE: 0.25 ampere fuse which provides protection against line voltage surges.
10. DC OUT jack: telephone-type jack which provides negative 1-volt dc out at full scale deflection, output is proportional to meter deflection. Output impedance is 1000 ohms.

Figure 3-1. Model 3400A Controls and Indicators

Approved For Release 2001/05/07 : CIA-RDP70B00584R000100250001-6

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section consists of instructions and information necessary for the operation of the ⓗ Model 3400A RMS Voltmeter. This section contains identification of controls and indicators, turn-on procedures, and operating instructions. Also included is a discussion of the applications for the Model 3400A.

3-3. CONTROLS AND INDICATORS.

3-4. Each operating control, connector, and indicator located on the Model 3400A is identified and described in Figure 3-1. The description of each component is keyed to an illustration of that component which is included within the figure.

3-5. TURN ON PROCEDURE.

3-6. To turn on the Model 3400A, proceed as follows:

a. Set 115/230 switch (7, Figure 3-1) to correct position for input line voltage.

b. Apply ac voltage to Model 3400A by plugging power cord into input power jack (8) ac receptacle.

c. Operate power switch (4) to ON; ensure that LINE indicator (3) lights.

NOTE
Allow five minutes for the Model 3400A to warm up and stabilize before making a reading.

3-7. OPERATING INSTRUCTIONS.

3-8. To operate the Model 3400A as an rms voltmeter proceed as follows:

a. Attach test lead to INPUT connector (6, Figure 3-1). (See Table 1-3 for a list of test leads available.)

b. Set RANGE switch (5) to 300 VOLTS position.

c. Connect test lead to point to be measured.

d. Rotate RANGE switch in a counterclockwise direction (decreased attenuation) until direct reading meter (1) indicates on upper two thirds of scale.

3-9. APPLICATIONS.

3-10. The Model 3400A can be used in conjunction with other test instruments to measure the rms value of ac signal with a dc component, measure rms current, and act as an rms ac-to-dc converter. For additional information of information on special applications, contact your ⓗ Sales and Service Office. (See Appendix B for office locations.)

3-11. RMS VALUE OF AC SIGNALS WITH DC COMPONENT.

3-12. Since the 3400A is an ac device it will measure only the rms value of the ac component of a wave. If it is necessary to include the rms value of the dc component when measuring a signal, use a ⓗ Model 412A DC Voltmeter to measure the dc component. Substitute the reading from the Model 412A and Model 3400A in the following formula:

$$e_{rms} = \sqrt{e_{ac}^{2} + e_{dc}^{2}}$$

3-13. RMS CURRENT.

3-14. To measure rms current, use an ⓗ Model 456A AC Current Probe. This probe clips around the current conductor and provides an output voltage that is proportional to the current being measured. Using this method, rms currents of one milliampere to one ampere can be measured.

3-15. RMS TO AC-TO-DC CONVERTER.

3-16. Since the Model 3400A is provided with a dc output (10, Figure 3-1) which is proportional to the meter deflection, it can be used as a linear rms ac to dc converter. The dc output can be used to drive a ⓗ Model 3440A Digital Voltmeter for high resolution measurements and/or a Mosely Model 680 Strip Chart Recorder where an analog record is desired. External loading does not affect the meter accuracy so that both the meter and dc output can be used simultaneously.

3-17. The dc output can be used to close control loops where it is desirable to hold the rms value of a given signal constant.

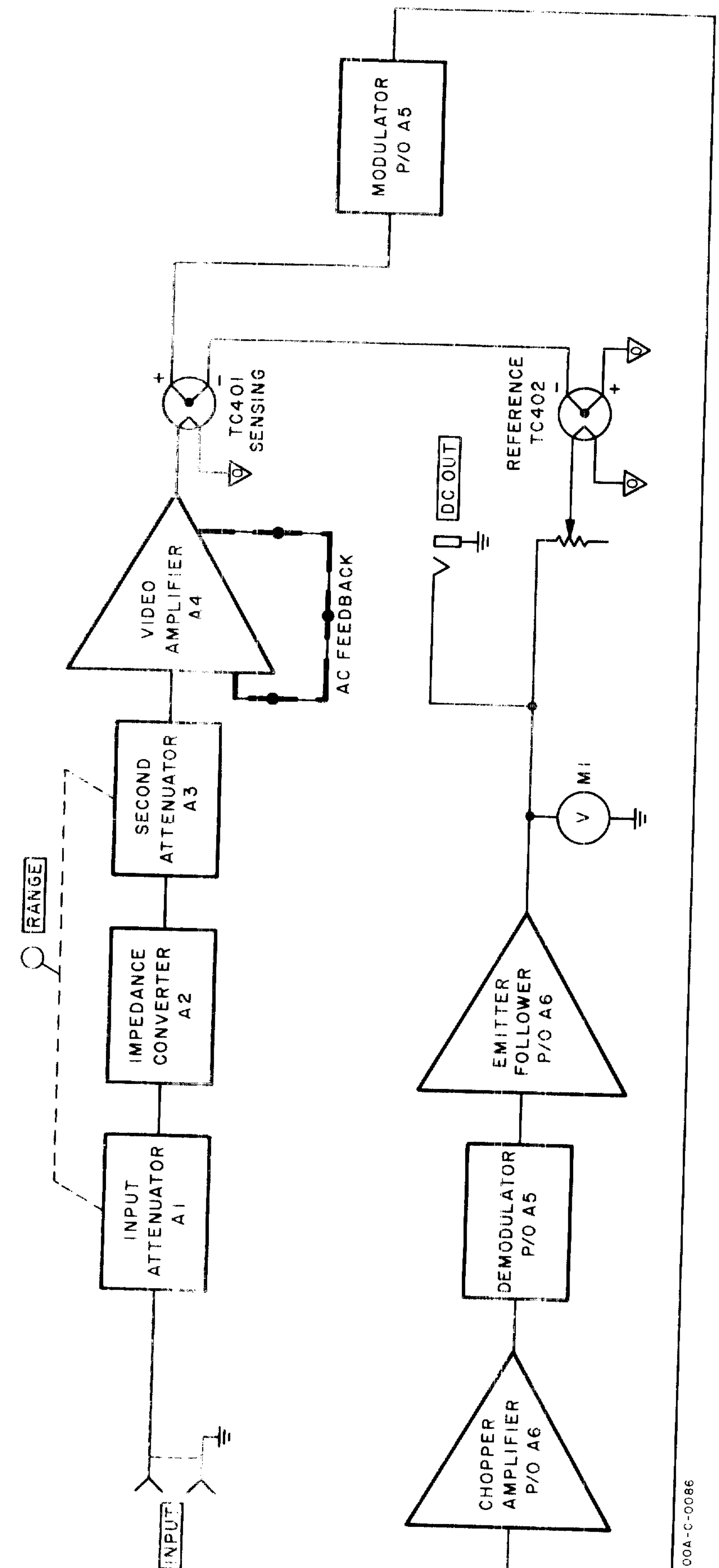


Figure 4-1. Simplified Block Diagram

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SECTION IV

THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains the theory of operation of the Model 3400A RMS Voltmeter. Included is a general and detailed description of the theory of operation.

4-3. GENERAL DESCRIPTION.

4-4. The Model 3400A comprises two attenuators, an impedance converter, a video amplifier, a modulator/ demodulator, a chopper amplifier, an emitter follower, a thermocouple pair, and a direct reading meter. (See Figure 4-1.)

4-5. A signal being measured with the Model 3400A is applied to input attenuator A1 through the INPUT jack, located on the Model 3400A front panel. The input attenuator has an input impedance of over 10 megohms and provides two ranges of attenuation. The output of the input attenuator is applied to impedance converter A2. The impedance converter is a non-inverting unity voltage gain amplifier. It presents a high impedance to the input signal and provides a low impedance output to drive the second attenuator A3. The second attenuator provides 6 ranges in a 1, 3, 10 sequence. The two attenuators are switched to provide 12 ranges of attenuation.

4-6. The output of the second attenuator is amplified by video amplifier A4. The video amplifier is a wideband, five stage amplifier. The overall gain of the video amplifier is controlled by an ac feedback loop. The ac output of the amplifier is applied to TC401; one of the thermocouples of the thermocouple pair.

4-7. The dc output of TC401 is modulated by modulator A5. The modulator comprises two photocells which are alternately illuminated by two neon lamps which in turn are controlled by the Model 3400A ac line voltage. Also applied to one of the photocells is the TC401 dc output. The resultant output of the modulator is a square wave whose amplitude is proportional to the dc input level.

4-8. The square wave output of the modulator is amplified by chopper amplifier A6. The chopper amplifier is a three-stage, high gain ac amplifier. Its output is applied to demodulator A5. The demodulator output is a dc level whose magnitude is proportional to the amplitude of the ac input. The demodulator output is applied to a two-stage, direct coupled emitter follower. The emitter follower is used to make the impedance transformation from the high impedance output of the demodulator to the low impedance of the direct reading meter M1 and TC402; the second thermocouple of the thermocouple pair.

4-9. The thermocouple pair acts as a summing point for the ac output of the video amplifier A4 and the dc output of the emitter follower. The difference in the heating effect of these voltages is felt as a dc input to modulator A5. This difference input is amplified and is fed to TC402 and to meter M1. This amplified dc voltage represents the rms value of the ac signal applied at the INPUT jack.

4-10. The dc voltage driving meter M1 is also available at the DC OUT jack, located at the rear of the Model 3400A.

4-11. DETAILED DESCRIPTION.

4-12. INPUT ATTENUATOR ASSEMBLY A1.

4-13. The input attenuator assembly is a capacitive-compensated attenuator which provides two ranges of attenuation for the 12 positions of the RANGE switch. See input attenuator schematic diagram illustrated on Figure 6-1.

4-14. When the RANGE switch is positioned to one of the six most sensitive ranges (.001 to .3 VOLTS), the attenuator output voltage is equal to the input voltage. When the RANGE switch is positioned to one of six highest ranges (1 to 300 VOLTS), the input signal is attenuated 60 db (1000:1 voltage division) by the resistive voltage divider consisting of R101, R103, and R104. Trimmer C102 is adjusted at 100 kc, and R104 is adjusted at 400 cps to provide constant attenuation over the input frequency range.

4-15. IMPEDANCE CONVERTER ASSEMBLY A2.

4-16. The impedance converter assembly utilizes a nuvistor tube cathode follower circuit to match the high output impedance of the input attenuator to the low input impedance of the second attenuator. The cathode follower circuit preserves the phase relationship of the input and output signals while maintaining a gain of unity. See impedance converter assembly schematic diagram illustrated on Figure 6-1.

4-17. The ac signal input to the impedance converter is RC coupled to the grid of cathode follower V201 through C201 and R203. The output signal is developed by Q201 which acts as a variable resistance in the cathode circuit of V201. The bootstrap feedback from the cathode of V201 to R203 increases the effective resistance of R203 to the input signal. This prevents R203 from loading the input signal and preserves the high input impedance of the Model 3400A. The gain compensating feedback from the plate of V201 to the base of Q201 compensates for a decrease in gain of V201 caused by tube aging.

4-18. Breakdown diode CR201 controls the grid bias voltage on V201 thereby establishing the operating point of this stage. CR202 across the base-emitter junction of Q201 protects Q201 in the event of a failure in the +75 volt power supply. Regulated dc is supplied to V201 filaments to avoid inducing ac hum in the signal path.

4-19. SECOND ATTENUATOR ASSEMBLY A3.

4-20. The second attenuator is a resistive divider which attenuates the ac input signal while maintaining a low impedance output for the following amplification stages. See second attenuator assembly schematic diagram illustrated in Figure 6-1.

4-21. The ac input signal is applied to a precision resistance voltage divider consisting of R302 through R312. These resistors are arranged to give six attenuation ranges from 0.001 to 0.3 volts. Trimmer capacitor C303 (.3V ADJ) provides an adjustment for frequency response at the higher frequencies.

4-22. VIDEO AMPLIFIER ASSEMBLY A4.

4-23. The video amplifier functions to provide constant gain to the ac signal being measured over the Model 3400A operating ranges. See video amplifier assembly schematic diagram illustrated on Figure 6-2.

4-24. The ac input signal from the second attenuator is coupled through C402 to the base of input amplifier Q401. Q401, a class A amplifier, amplifies and inverts the signal which is then direct coupled to the base of bootstrap amplifier Q402. The output, taken from Q402 emitter is applied to the base of Q403 and fed back to the top of R406 as a bootstrap feedback. This positive ac feedback increases the effective ac resistance of R406 allowing a greater portion of the signal to be felt at the base of Q402. In this manner, the effective ac gain of Q401 is increased for the mid-band frequencies without disturbing the static operating voltages of Q401.

4-25. Driver amplifier Q403 further amplifies the ac signal and the output at Q403 collector is fed to the base circuit of emitter follower Q404. The feedback path from the collector of Q403 to the base of Q402 through C405 (10 MC ADJ) prevents spurious oscillations at high input frequencies. A dc feedback loop exists from R433, in the emitter circuit of Q403, to the base of Q401. This feedback stabilizes the Q401 bias voltage. Emitter follower Q404 acts as a driver for the output amplifier consisting of Q405 and Q406; a complimentary pair operating as a push-pull amplifier. The video amplifier output is taken from the collectors of the output amplifiers and applied to thermocouples TC401. A gain stabilizing feedback is developed in the emitter circuits of the output amplifiers. This negative feedback is applied to the emitter of input amplifier Q401 and establishes the overall gain of the video amplifier.

4-26. Trimmer capacitor C405 is adjusted at 10 mc for frequency response of the video amplifier. Diodes CR402 and CR406 are protection diodes which prevent voltage surges from damaging transistors in the video amplifier. CR401, CR407, and CR408 are temperature compensating diodes to maintain the zero signal balance condition in the output amplifier over the operating temperature range. CR403, a breakdown diode, establishes the operating potentials for the output amplifier.

4-27. MODULATOR/DEMODULATOR ASSEMBLY A5, CHOPPER AMPLIFIER ASSEMBLY, AND THERMOCOUPLE PAIR ASSEMBLY (PART OF A4).

4-28. The modulator/demodulator, chopper amplifier, and thermocouple pair form a servo loop which functions to position the direct reading meter M1 to the rms value of the ac input signal. See modulator/demodulator, chopper amplifier, and thermocouple pair schematic diagram illustrated in Figure 6-3.

4-29. The video amplifier output signal is applied to the heater of thermocouple TC401. This ac voltage causes a dc voltage to be generated in the resistive portion of TC401 which is proportional to the heating effect (rms value) of the ac input. The dc voltage is applied to photocell V501.

4-30. Photocells V501 and V502 in conjunction with neon lamps DS501 and DS502 form a modulator circuit. The neon lamps are lighted alternately at the line voltage frequency. Each lamp illuminates one of the photocells. DS501 illuminates V501; DS502 illuminates V502. When a photocell is illuminated it has a low resistance (approximately 6K ohms) compared to its resistance when dark (approximately 500K ohms). Therefore, when V501 is illuminated, the output of thermocouple TC401 is applied to the input of the chopper amplifier through V501. When V502 is illuminated, the ground signal felt through R634 is applied to the chopper amplifier. The alternate illumination of V501 and V502 modulates the dc input at the Model 3400A line frequency. The modulator output is a square wave whose amplitude is proportional to the input dc level.

4-31. The chopper amplifier, consisting of Q601 through Q603, is a high gain amplifier which amplifies the square wave developed by the modulator. Noise and power supply voltage variations are reduced by breakdown diode CR601 and CR603. Diodes CR602 and CR603 compensate for temperature changes over the operating range. The amplified output is taken from the collector of Q603 and applied to the demodulator through C605.

4-32. The demodulator comprises two photocells, V503 and V504, which operate in conjunction with DS501 and DS502; the same neon lamps used to illuminate the photocells in the modulator. Photocells V503 and V504 are illuminated by DS501 and DS502, respectively.

4-33. The demodulation process is the reverse of the modulation process discussed in paragraph 4-30. The output of the demodulator is a dc level which is proportional to the demodulator input. The magnitude and phase of the input square wave determines the magnitude and polarity of the dc output level. This dc output level is applied to the emitter follower consisting of Q604 and Q605.

4-34. The emitter follower is needed to match the high output impedance of the demodulator to the low impedance input of the meter and thermocouple circuits. The voltage drop across CR604 in the collector circuit of Q604 is the operating bias for Q604. This fixed bias prevents Q604 failure when the base voltage is zero with respect to ground.

4-35. The dc level output, taken from the emitter of Q605, is applied to meter M1 and to the heating element of thermocouple TC402. The voltage developed in the resistive portion of TC402 is effectively subtracted from the voltage in TC401. The input signal to the modulator then becomes the difference in the dc outputs of the two thermocouples.

4-36. A frequency stabilizing feedback path exists through C610 and C611 during one half cycle of the modulated square wave and through C607 and C608 during the other half cycle. Ac components in the modulated square wave which are not synchronized with the modulated square wave receive heavy attenuation due to this negative feedback. In this manner, the chopper amplifier is effectively tuned to the modulator frequency.

4-37. POWER SUPPLY ASSEMBLY A7.

4-38. The power supply assembly provides the operating voltages for the tube and transistors used in the Model 3400A. See power supply assembly schematic diagram illustrated on Figure 6-4.

4-39. Either 115 or 230 volts ac is connected to the primary of power transformer T1 through fuse F1 and the POWER switch S1. Switch S2 (slide switch on rear panel) connects T1 primary windings in series for 230-volt operation or in parallel for 115-volt operation. Neon lamp DS1 lights to indicate power ON when ac power is applied and S1 is closed.

4-40. REGULATOR OPERATION.

4-41. The series regulator acts as a dynamic variable resistor is series with the power supply output. A control amplifier senses changes in the output voltage by comparing the output with a fixed reference voltage. The control amplifier then supplies any output voltage changes to the driver transistor, which in turn changes the resistance of the series regulator to oppose the change in output voltage. Diodes across the base emitter junction of the series regulator provide over current protection.

4-42. +75 VOLT SUPPLY.

4-43. The +75-volt supply consists of a full-wave rectifier (CR701 and CR702) whose output is filtered by C1A and C1B and regulated by series regulator Q1. The +75-volt supply provides regulated +75 volts which is used as the plate supply voltage for V201. Voltage variation from the output is felt at Q702 base circuit through C704, R715, and R716. The C703 and R709 network provides phase correction for power supply stability. The regulation circuitry is in the negative leg of the +75-volt supply, and uses the -17.5-volt supply as a reference.

4-44. -17.5-VOLT SUPPLY.

4-45. The regulated -17.5-volt supply consists of a full-wave rectifier (CR711, and CR712) whose output is filtered by C706 and C707 and regulated by Q2. Breakdown diode CR715 provides reference voltage at the base of Q704. Regulation operation is the same described in paragraph 4-40.

4-46. -6 VOLT SUPPLY.

4-47. The regulated -6.3-volt supply consists of a full-wave rectifier (CR716 and CR717) whose output is filtered by C2 and regulated by Q3. Emitter follower Q705 is connected to the -17.5-volt supply which provides a reference for the -6.3-volt supply. Series regulator Q3 acts as a dynamic variable resistor in series with the output to oppose changes in output voltage.

Table 5-1. Required Test Equipment

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
DC Voltmeter/ Ohmmeter	Voltmeter Accuracy: ±.1% full scale Voltage Range: 10 mv to 100 v Ohmmeter Accuracy: ±3% Ohms Range: 2 Ω to 100 M Ω	Performance Checks Power Supply Checks Alignment and Adjustment Troubleshooting	hp Model 3440A/3444A Digital Voltmeter
Voltmeter Calibrator	Voltage Range: 1 mv to 300 v rms Frequency: 400 cps Accuracy: ±0.2%	Performance Checks Alignment and Adjustment	hp Model 738B Voltmeter Calibrator
Oscillator	Frequency Stability: .001%/minute Frequency Range: 10 cps to 10 Mc	Performance Checks Alignment and Adjustment Troubleshooting	hp Model 651A Test Oscillator
Frequency Response	Frequency Range (with external oscillator): 15 cps to 10 Mc Frequency Response: ±0.5%, 15 cps to 10 Mc	Performance Checks Alignment and Adjustment	hp Model 739AR Frequency Response Test Set
Oscilloscope	Sensitivity: 0.1 v/cm Bandwidth: 2 cps to 50 Mc	Performance Checks Power Supply Checks Troubleshooting	hp Model 175A/1750B 50 Mc Oscilloscope
Pulse Generator	Pulse Width: variable to 10 μsec Pulse Amp: ±2 volts peak, variable Pulse Rate: 250 to 1000 pps	Performance Checks	hp Model 212A Pulse Generator
Pulse Counter	Range: 250 to 1000 pps Accuracy: ±1 count	Performance Checks	hp Model 5512A Electronic Counter
AC Voltmeter	Voltage Range: 1 to 150 v Accuracy: ±3%	Power Supply Checks Troubleshooting	hp Model 403A/B AC Voltmeter
Power Supply 200 K Ω Resistor	Output: 0 - 1 vdc, variable Metal film, 1/4 w, 1%	Troubleshooting Performance Checks	hp Model 721A hp Part No. 0757-0782
50 Ω Feed-Thru Termination	Resistor: fixed, composition, 50 ohms ±5%, 1/4 w	Performance Checks Alignment and Adjustment	hp Model 11048B 50 Ohm Feed-Thru Termination
BNC-T-Adapter	UG-274B/U	Performance Checks Alignment and Adjustment	hp Part No. 1250-0072
Adapter-Connector	UG-201A/U	Performance Checks Alignment and Adjustment	hp Part No. 1250-0067

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains the information necessary for maintenance of the Model 3400A RMS Voltmeter. Included are performance checks, repair procedures, adjustment and calibration procedures, and trouble-shooting techniques.

5-3. TEST EQUIPMENT.

5-4. The test equipment required for the maintenance of the Model 3400A is listed in Table 5-1. Equipment having similar characteristics may be substituted for the equipment listed.

5-5. PERFORMANCE CHECKS.

5-6. The performance checks presented in this section are front-panel procedures designed to compare the Model 3400A with its published specifications. These checks can be incorporated in periodic maintenance, post-repair, and incoming quality control inspection. These checks should be conducted before any attempt is made at instrument calibration. During all performance checks, periodically vary the Model 3400A line voltage ±10%.

NOTE

Allow a 30-minute warm-up period before making performance checks.

5-7. ACCURACY, LINEARITY, AND DC OUTPUT PERFORMANCE CHECK.

5-8. The accuracy, linearity, and dc output test setup is illustrated in Figure 5-1. A Voltmeter Calibrator (hp Model 738B) and a DC Voltmeter (hp Model 3440A/3444A) are required for this test.

a. Connect test setup illustrated in Figure 5-1.

b. Set Model 3400A RANGE switch to .001 position.

c. Adjust Voltmeter Calibrator for 0.001 volt, 400 cps output; set dc voltmeter to measure 1 volt.

d. If Model 3400A does not indicate within values listed under METER READING in Table 5-2, perform low frequency calibration procedure, Paragraph 5-31.

e. Dc output as indicated on dc voltmeter should be within values listed under DC OUTPUT in Table 5-2.

f. Repeat steps c thru e for remaining voltage values listed under VOLTMETER CALIBRATOR OUTPUT in Table 5-2.

Table 5-2. Accuracy, Linearity, and DC Output Performance Check, Supplemental Data

VOLTMETER CALIBRATOR OUTPUT	METER READING	DC OUTPUT
0.001 v	0.00099 to 0.00101	0.990 to 1.01
0.003 v	0.00297 to 0.00303	0.940 to 0.960
0.1 v	0.099 to 0.101	0.990 to 1.01
0.3 v	0.297 to 0.303	0.940 to 0.960
1.0 v	0.99 to 1.01	0.990 to 1.01
3.0 v	2.97 to 3.03	0.940 to 0.960
30.0 v	29.7 to 30.3	0.940 to 0.960
100.0 v	99.0 to 101.0	0.990 to 1.01
300.0 v	297.0 to 303.0	0.940 to 0.960

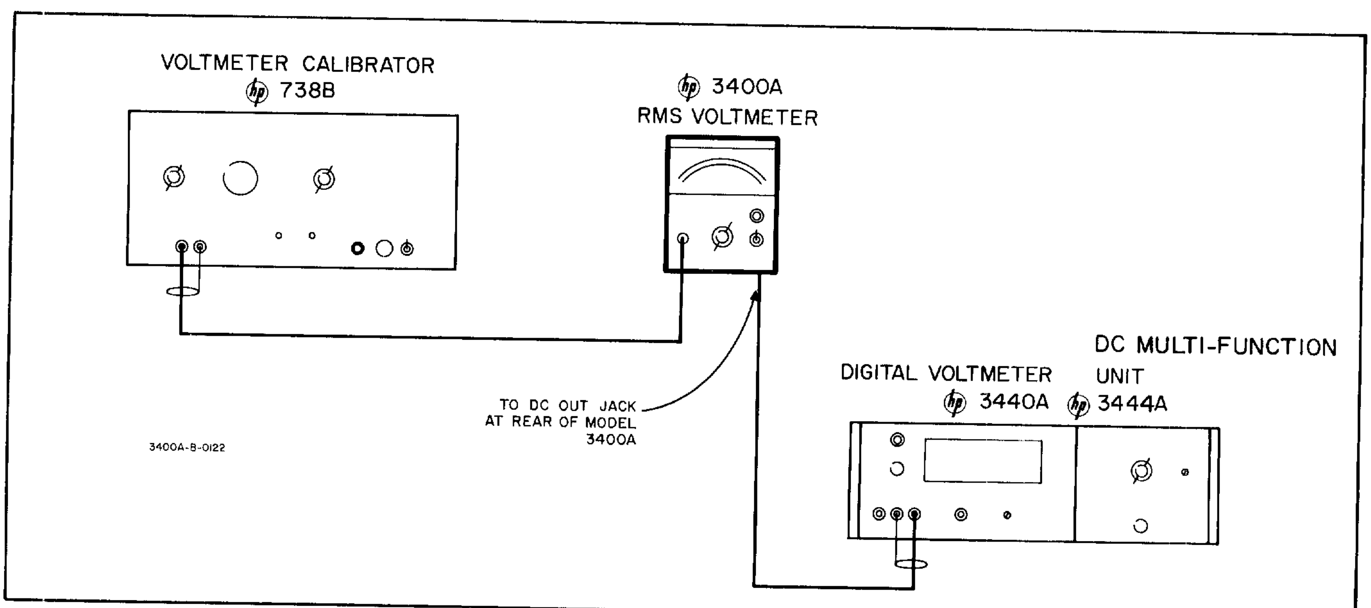

Figure 5-1. Accuracy, Linearity, and DC Output Test Setup

5-9. FREQUENCY RESPONSE PERFORMANCE CHECK.

5-10. The frequency response test setup is illustrated in Figure 5-2. A Frequency Response Test Set (hp Model 739AR) and an Oscillator (hp Model 651A) are required for this test.

NOTE

The Frequency Response Test Set used to check the 3400A accuracy should be calibrated at the end of its output cable. At 10 Mc there is typically a 2% loss in the 739A output cable.

a. Connect test setup illustrated in Figure 5-2.

b. Set Model 3400A RANGE switch and frequency response test set output attenuator to 1 volt position.

c. Set frequency response test set to use external input.

d. Adjust oscillator output frequency for 400 cps; output voltage for 90% full scale as indicated on Model 3400A meter.

e. Adjust frequency response test set meter to convenient reference.

f. Adjust oscillator output frequency to values listed under FREQUENCY in Table 5-3; adjust oscillator output voltage to maintain reference set in step e. If Model 3400A does not indicate within values under METER READING in Table 5-3, perform high frequency calibration procedures, Paragraph 5-36.

5-11. INPUT IMPEDANCE PERFORMANCE CHECK.

5-12. An Oscillator (hp Model 651A) and a 200K Ω resistor (hp Part No. 0757-0782) are required for the input impedance performance check.

a. Set Model 3400A RANGE switch to 1 volt position.

b. Adjust oscillator output frequency to 50 cps; output voltage for full-scale deflection as indicated on Model 3400A.

c. Insert 200 K Ω resistor in series with Model 3400A input; meter reading should change less than 0.02 volts. This corresponds to an input impedance of 10 megohms where:

$$E_{change} = \frac{E_{app} R_{series}}{R_{total}}$$

d. Adjust oscillator frequency to 50 Kc; Model 3400A reading should be greater than 0.7 volts. This corresponds to input shunt capacity of less than 15 pf.

e. Set Model 3400A RANGE switch to .001 position.

f. Repeat steps b and c.

g. Adjust oscillator frequency to 18 Kc; Model 3400A reading should be greater than 0.7 volts. This corresponds to an input shunt capacity of less than 40 pf.

Table 5-3. Frequency Response Performance Check, Supplemental Data

FREQUENCY	METER READING
15 cps	0.95 to 1.05
45 cps	0.95 to 1.05
100 cps	0.99 to 1.01
900 Kc	0.99 to 1.01
1.2 Mc	0.98 to 1.02
1.8 Mc	0.98 to 1.02
2.2 Mc	0.97 to 1.03
2.8 Mc	0.97 to 1.03
3.2 Mc	0.95 to 1.05
9.8 Mc	0.95 to 1.05

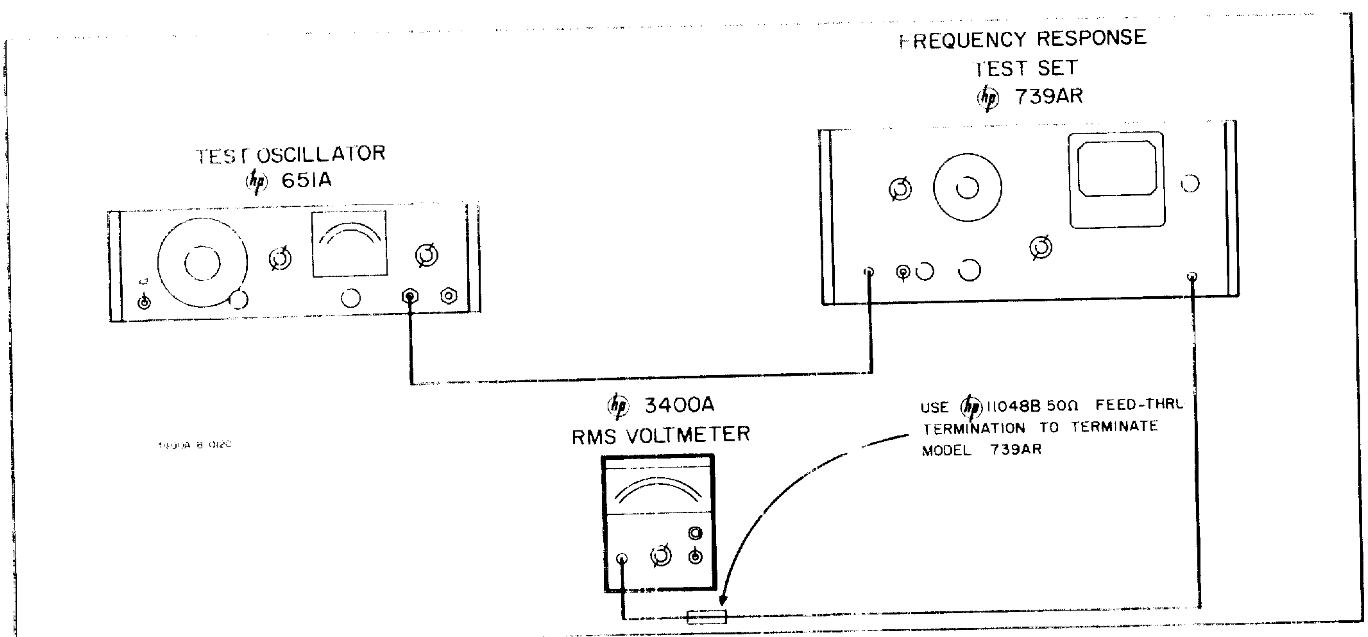

Figure 5-2. Frequency Response Test Setup

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5-13. CREST FACTOR PERFORMANCE CHECK.

5-14. The crest factor performance check test setup is illustrated in Figure 5-3. A Pulse Generator (hp Model 212A), a High Frequency Oscilloscope (hp Model 175A/1750B), and an Electronic Counter (hp Model 5512A) are required for this test.

a. Connect test setup illustrated in Figure 5-3.

b. Set Model 3400A RANGE switch to 0.1 volt position.

c. Adjust pulse generator for pulse output with following characteristics:

E peak.	1.00 v as indicated on oscilloscope
Pulse Rate	990 pps as indicated on electronic counter
Pulse Width. . . .	10 μsec

This corresponds to a crest factor of 10 where:

$$E_{rms} = E\sqrt{D(1-D)} \text{ where } D = T_0/T$$

$$CF = \frac{E\ peak}{E\ rms}$$

$$= \frac{E\ (1-D)}{E\sqrt{D(1-D)}}$$

$$= \sqrt{\frac{1-D}{D}}$$

d. Model 3400A should indicate 0.1 volt (±5%).

e. Adjust pulse generator pulse rate to 250 pps as indicated on electronic counter; this corresponds to a crest factor of 20.

f. Model 3400A should indicate 0.05 volts (±5%).

5-15. RESIDUAL NOISE PERFORMANCE CHECK.

5-16. A 100 K Ω shielded load is required for the residual noise performance check.

a. Connect 100 K Ω shielded load to the Model 3400A INPUT.

b. Rotate RANGE switch to 0.001. Zero offset should be less than 5% of full scale.

5-17. REPAIR PROCEDURES.

5-18. COVER REMOVAL.

5-19. When it is necessary to repair or adjust the Model 3400A, one or more covers will have to be removed. Refer to Figure 5-4 and the following steps for cover removal procedure.

a. TOP COVER. Remove top cover screw; slide cover to rear and lift to remove.

b. SIDE COVERS. Remove four screws in side cover; lift to remove.

c. BOTTOM COVER. Remove bottom cover screw at rear of cover. Slide cover to rear and remove.

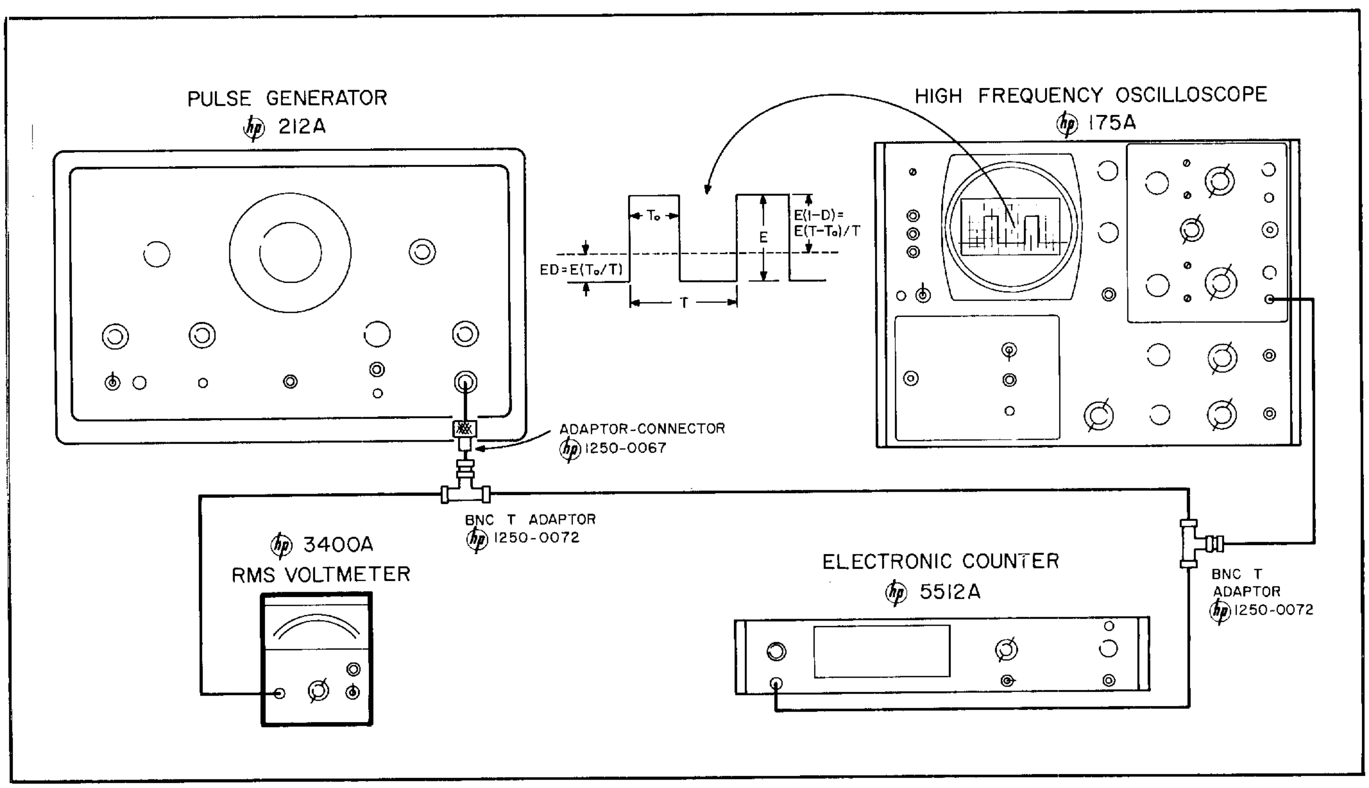

Figure 5-3. Crest Factor Test Setup

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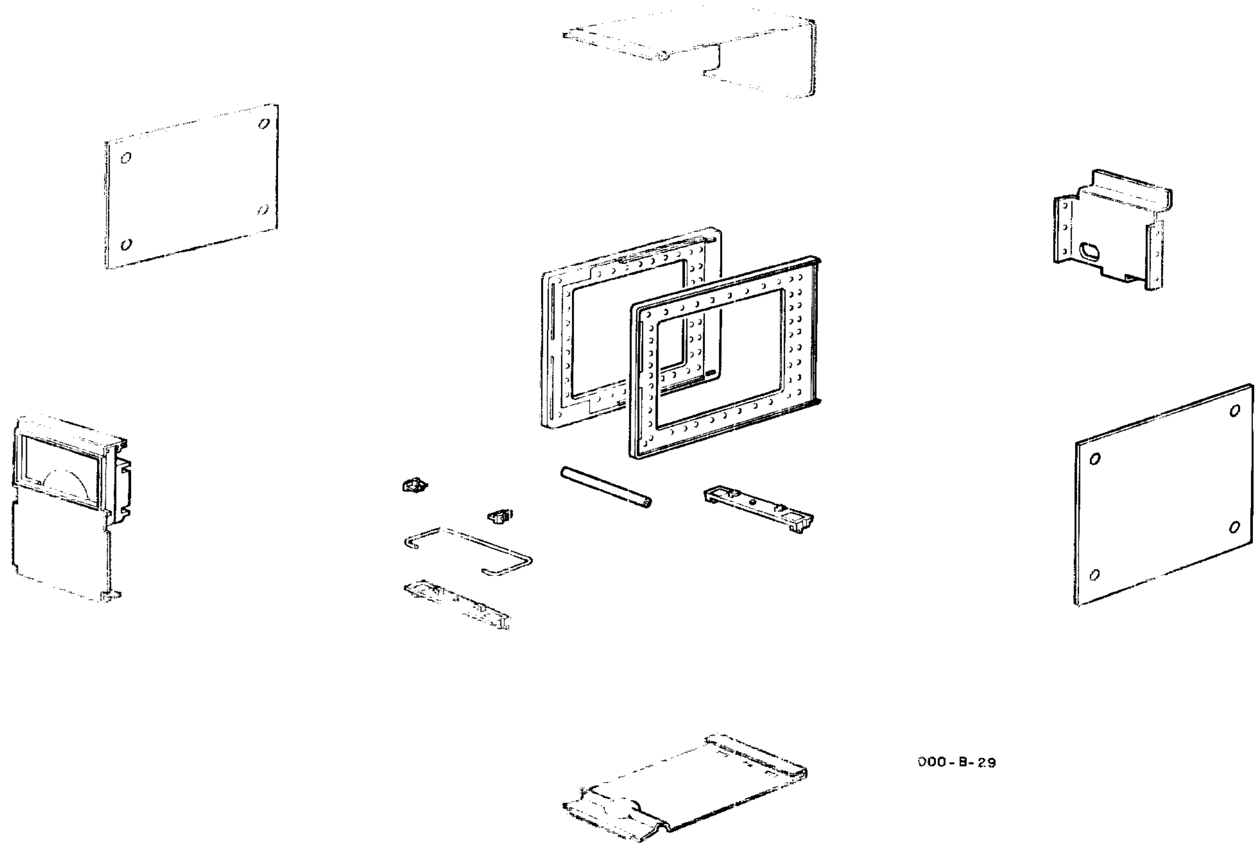


Figure 5-4. Model 3400A Modular Cabinet

5-20. SERVICING ETCHED CIRCUIT BOARDS.

5-21. The ⓗⓟ Model 3400A has five etched circuit boards. Use caution when removing them to avoid damaging mounted components. The assembly and ⓗⓟ Part No. are silk screened on the interior of the circuit board to identify it. Refer to Section VII for parts replacement and ⓗⓟ Part Number information.

5-22. The etched circuit boards are a plated-through type. The electrical connection between sides of the board is made by a layer of metal plated through the component holes. When working on these boards, observe the following general rules.

a. Use a low-heat (25 to 50 watts) small-tip soldering iron and a small diameter rosin core solder.

b. Circuit components can be removed by placing the soldering iron on the component lead on either side of the board and pulling up on lead. If a component is obviously damaged, clip leads as close to component as possible and then remove. Excess heat can cause the circuit and board to separate or cause damage to the component.

c. Component lead hole should be cleaned before inserting new lead.

d. To replace components, shape new leads and insert them in holes. Reheat with iron and add solder as required to insure a good electrical connection.

e. Clean excess flux from the connection and adjoining area.

f. To avoid surface contamination of the printed circuit, clean with weak solution of warm water and mild detergent after repair. Rinse thoroughly with clean water. When completely dry, spray lightly with Krylon (#1302 or equivalent).

5-23. THERMOCOUPLE REPLACEMENT.

CAUTION

Exercise extreme care when removing or replacing the amplifier printed circuit board assembly and when shaping the thermocouple leads.

5-24. Should a thermocouple be defective, it is necessary to replace both as a matched pair (see Section VII, Table of Replaceable Parts) to ensure for proper operation. To replace thermocouples, proceed as follows:

a. Turn instrument power off and remove left side and top covers.

b. Remove two screws in left side of amplifier board and one screw through ground lug connecting board to chassis.

c. Lift board slightly to clear lanced guide on chassis. Gently pull bottom of board to outside until board will drop down and top will clear main frame. Adjust amplifier input and output cables to ensure free passage through grommets and carefully fold board down to expose the four nuts holding the thermocouple shield.

d. Remove four shield nuts; lift shield off. Remove thermocouples, noting orientation.

e. Leads must be shaped before inserting new thermocouples. Ensure that red dot on thermocouples face board. During the shaping process, hold leads between bending point and glass with long-nose pliers.

f. Carefully install new thermocouples and solder. Refer to Paragraph 5-22.

g. Clean the board as discussed in Paragraph 5-22. Carefully mask thermocouple shield during spraying.

h. Apply silicon grease (Dow Corning 5 Compound or equivalent) to shield contact edges.

j. Reverse steps d, c, b, and a for reassembly.

k. Refer to Paragraph 5-25 and calibrate the amplifier.

5-25. ADJUSTMENT AND CALIBRATION PROCEDURES.

5-26. The following is a complete adjustment and calibration procedure for the Model 3400A. These operations should be conducted only if it has previously been established by Performance Checks, Paragraphs 5-5 to 5-16, that the Model 3400A is out of adjustment. Indescriminate adjustment of the internal controls to refine settings may actually cause more difficulty. If the procedures outlined do not rectify any maladjustments that may exist, and you have carefully rechecked your connections and settings, refer to Paragraph 5-41, Troubleshooting, for possible cause and recommended corrective action.

5-27. MECHANICAL METER ZERO.

5-28. The mechanical meter zero screw is located on the instrument front panel. If the meter pointer does not indicate zero when the instrument power has been off for at least one minute, mechanically zero the meter following the procedure outlined below.

a. Turn instrument power off; disconnect input signal; remove cable from J2 (DC OUT) at rear of instrument; and allow one minute for meter pointer to stabilize.

b. Rotate zero adjust CW until pointer is to left of zero, moving up scale. Continue until pointer is at zero. If pointer overshoots zero, repeat operation.

c. When the pointer is exactly at zero, rotate the adjusting screw slightly counterclockwise to free it. If the meter pointer moves to the left during this adjustment, repeat steps b through c.

Table 5-4. Power Supply Checks

POWER SUPPLY	TEST EQUIPMENT AND CHECK POINT	DC VOLTAGE SPECIFICATIONS	REGULATION (Vary line voltage between 103.5 and 126.5 vac)	RIPPLE SPECIFICATIONS
-17.5 vdc	Connect DC Voltmeter, AC Voltmeter, or Oscilloscope to pin 1 (violet lead) on chopper amplifier (A6) and chassis ground.	-17 to -18 vdc	±0.5 volt from nominal reading at 115 vac line.	400 μv rms or 1.1 mv p-p
+75 vdc	Connect DC Voltmeter, AC Voltmeter, or Oscilloscope to pin 15 (red/wht/blue) of chopper amplifier (A6) and chassis ground.	70.0 to 78.0 vdc	±1 volt from nominal reading at 115 vac line.	400 μv rms or 1.1 mv p-p
-6.3 vdc	Connect DC Voltmeter, AC Voltmeter, or Oscilloscope to Q3 emitter (grey lead) and chassis ground.	-5.9 to -6.5 vdc	±0.1 volt from nominal reading at 115 vac line.	2 mv rms or 5.7 mv p-p

5-29. POWER SUPPLY CHECKS.

5-30. Power supply voltage and ac ripple specifications are listed in Table 5-4. Test points are also indicated in this table. When making ripple voltage measurements, it may be desirable to isolate the ac testing instrument from power line ground to avoid any undesirable ground loop currents. Use a three-prong to two-prong adapter in the power line receptacle.

5-31. LOW FREQUENCY CALIBRATION.

5-32. The low frequency calibration comprises the amplifier gain adjustment, the 1/10 scale adjustment, and the 1 volt adjustment. A Voltmeter Calibrator (hp Model 738B) and a DC Voltmeter (hp Model 3440A/3444A) are required.

5-33. AMPLIFIER GAIN ADJUSTMENT.

a. Connect test setup illustrated in Figure 5-1.

b. Set Model 3400A RANGE switch to .01 volt position.

c. Adjust voltmeter calibrator for 0.01 volt, 400 cps output; set dc voltmeter to measure 1 volt.

d. Remove Model 3400A top cover; adjust R4 (CAL) for 1.0 volt as indicated on dc voltmeter. If R4 (CAL) does not have enough range to calibrate the dc output, the value of R3 should be changed. Typical range of R3 is from 1.0 K to 2.6 K ohms.

e. Adjust R6 (FULL SCALE ADJUST) for Model 3400A full-scale meter reading.

5-34. 1/10 SCALE ADJUSTMENT.

a. Connect test setup illustrated in Figure 5-1; omit dc voltmeter.

b. Set Model 3400A RANGE switch to .1 volt position.

c. Adjust voltmeter calibrator for 0.01 volt, 400 cps output.

NOTE

The 1/10 SCALE ADJUST should be set slightly low (needle's width) to reduce meter (needle) offset with shorted input.

d. Remove Model 3400A top cover; adjust R7 (1/10 SCALE ADJUST) for Model 3400A 1/10 scale meter reading.

5-35. 1 VOLT ADJUSTMENT.

a. Connect test setup illustrated in Figure 5-1.

b. Set Model 3400A RANGE switch to 1 volt position.

c. Adjust voltmeter calibrator for 1.0 volt, 400 cps output.

d. Adjust R104 (1 V ADJUST) for Model 3400A for full-scale reading.

5-36. HIGH FREQUENCY CALIBRATION.

5-37. The high frequency calibration comprises the amplifier gain adjustment, the input attenuator adjustment, and the second attenuator adjustment. A Frequency Response Test Set (hp Model 739AR) and an Oscillator (hp Model 651A) are required.

5-38. AMPLIFIER GAIN ADJUSTMENT.

NOTE

The frequency response test set used to calibrate the 3400A should be calibrated at the end of its output cable. At 10 Mc there is typically a 2% loss in the output cable.

a. Connect test setup illustrated in Figure 5-2.

b. Set Model 3400A RANGE switch and frequency response test set output attenuator to 1 mv position.

c. Set frequency response test set to use external input.

d. Adjust oscillator output frequency for 400 cps; output voltage for 90% full scale as indicated on Model 3400A meter.

e. Adjust frequency response test set meter to convenient reference.

f. Adjust oscillator output frequency for 10 Mc; output voltage to maintain reference set in step e.

g. Remove Model 3400A left-side cover; adjust C405 (10 MC ADJUST) for 90% full scale as indicated on Model 3400A meter. Replace cover; readjust C405 if meter reading varies from 90% full scale.

h. Vary oscillator between 3 and 10 Mc; maintain oscillator output voltage to reference set in step e. If Model 3400A meter reading varies below 85% or above 95% of full scale, repeat step g until optimum response is obtained between 3 and 10 Mc.

5-39. INPUT ATTENUATOR ADJUSTMENT.

NOTE

The frequency response test set used to calibrate the 3400A should be calibrated at the end of its output cable. At 10 Mc there is typically a 2% loss in the output cable.

a. Connect test setup illustrated in Figure 5-2.

b. Set Model 3400A RANGE switch and frequency response test set output attenuator to 1 volt position.

c. Set frequency response test set to use external input.

d. Adjust oscillator output frequency for 400 cps; output voltage for 90% full scale as indicated on Model 3400A meter.

e. Adjust frequency response test set meter to convenient reference.

f. Adjust oscillator output frequency for 100 Kc; output voltage to maintain reference in step e.

g. Remove Model 3400A bottom cover; adjust C102 (1 V, 100 KC ADJUST) for 90% full scale as indicated on Model 3400A meter. Replace cover; readjust C405 if meter reading varies from 90% full scale.

h. Vary oscillator between 100 Kc and 10 Mc; maintain oscillator output voltage to reference set in step e. If Model 3400A meter reading varies more than ±1% to 1 Mc, ±2% from 1 Mc to 2 Mc, ±3% from 2 Mc to 3 Mc, or ±5% from 3 Mc to 10 Mc, repeat step g until optimum response is obtained.

5-40. SECOND ATTENUATOR ADJUSTMENT.

NOTE

The frequency response test set used to calibrate the 3400A should be calibrated at the end of its output cable. At 10 Mc there is typically a 2% loss in the output cable.

a. Connect test setup illustrated in Figure 5-2.

b. Set Model 3400A RANGE switch and frequency response test set output attenuator to .3 volt position.

c. Set frequency response test set to use external input.

d. Adjust oscillator output frequency for 400 cps; output voltage for 90% full scale as indicated on Model 3400A meter.

e. Adjust frequency response test set meter to convenient reference.

f. Adjust oscillator output frequency for 3 Mc; output voltage to maintain reference in step e.

g. Remove Model 3400A bottom cover; adjust C303 (.3 V ADJ) for 90% full scale as indicated on Model 3400A meter.

h. Vary oscillator between 3 Mc and 10 Mc; maintain oscillator output voltage to reference set in step e. If Model 3400A meter reading varies below 85% or above 95% of full scale, repeat step g until optimum response is obtained between 3 and 10 Mc.

5-41. TROUBLESHOOTING PROCEDURE.

5-42. This section contains procedures designed to assist in the isolation of malfunctions. These operations should be undertaken only after it has been established that the difficulty cannot be eliminated by the Adjustment and Calibration Procedures, Paragraph 5-25. An investigation should also be made to ensure that the trouble is not a result of conditions external to the Model 3400A.

5-43. Conduct a visual check of the Model 3400A for possible burned or loose components, loose connections, or any other condition which might suggest a source of trouble.

5-44. Table 5-5 contains a summary of the front-panel symptoms that can be used in initial efforts to select a starting point for troubleshooting operations.

5-45. Table 5-6, in conjunction with Figure 5-5, contains procedures which may be used as a guide in isolating malfunctions. The steps in Table 5-6 describe the normal conditions which should be encountered during the checks (circled numbers N) in Figure 5-5.

5-46. The checks outlined in Table 5-6 are not designed to measure all circuit parameters, rather, only to localize the malfunction. Therefore, it is quite possible that additional measurements will be required to completely isolate the problem. Amplifier gain may also vary slightly between instruments; therefore, it should not be necessary to precisely duplicate waveforms or values described.

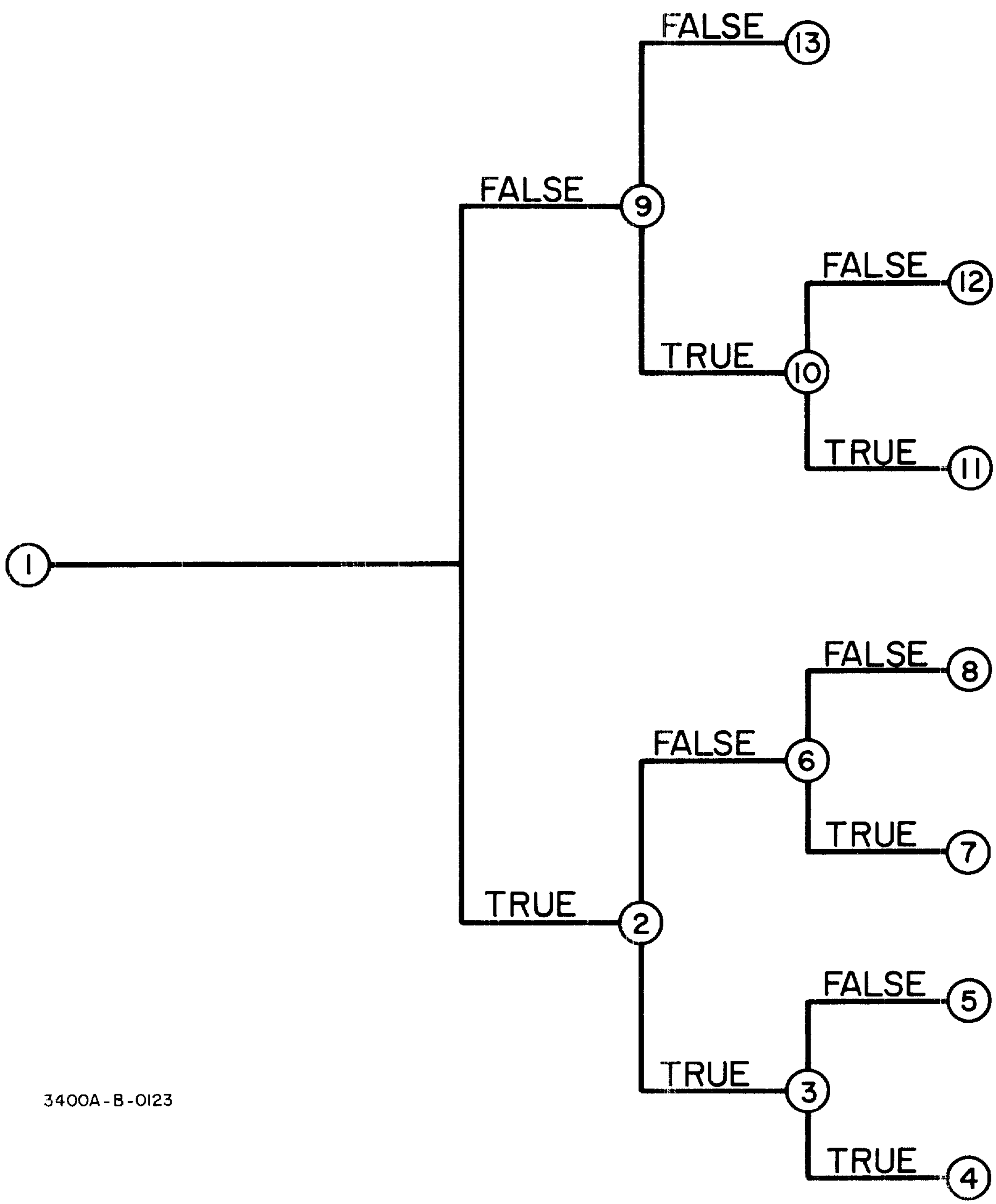
5-47. Voltage values indicated are based on 0.1 v rms input at 400 cps unless otherwise specified.

5-48. When required, check power supply voltages as outlined in Paragraph 5-29.

5-49. Figures 5-6 through 5-17 are typical waveforms in Model 3400A.

Table 5-5. Front Panel Symptoms

SYMPTOM	POSSIBLE CAUSE
1/2 scale readings on all RANGE switch settings and input voltages.	Chopper Amplifier (A6), C612.
3 to 5% meter offset on all ranges with shorted input.	R7 misadjusted. C405 misadjusted. Check Q605.
400 cps calibration low and frequency response falls off above 50 Kc.	Q401 or Q402 shorted.
Switching transients exceed 5% of full scale with shorted input.	Check collector voltage of Q201 (should not exceed 9.0 v).
Instrument has been overloaded.	Check Q201, Q401, and Q402.
Meter jitter or flutter exceeds 0.5% of full scale.	Check Q601, Chopper Assembly (neons).
Full-scale difference from range to range.	Check resistors in second attenuator.

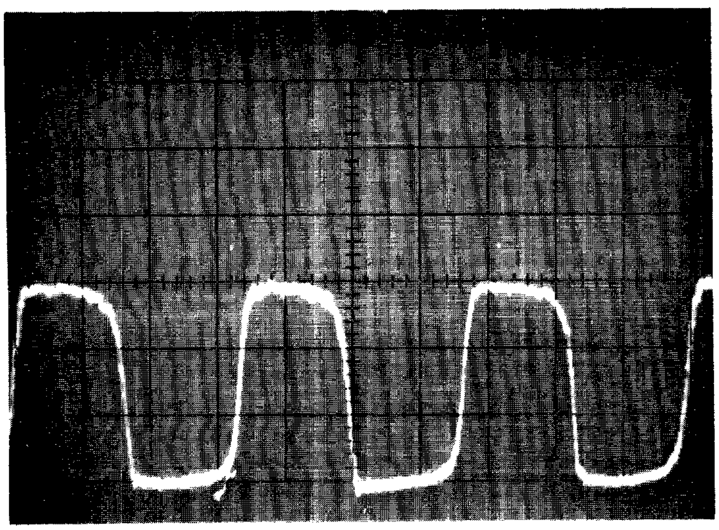


3400A-B-0123

Figure 5-5. Troubleshooting Tree

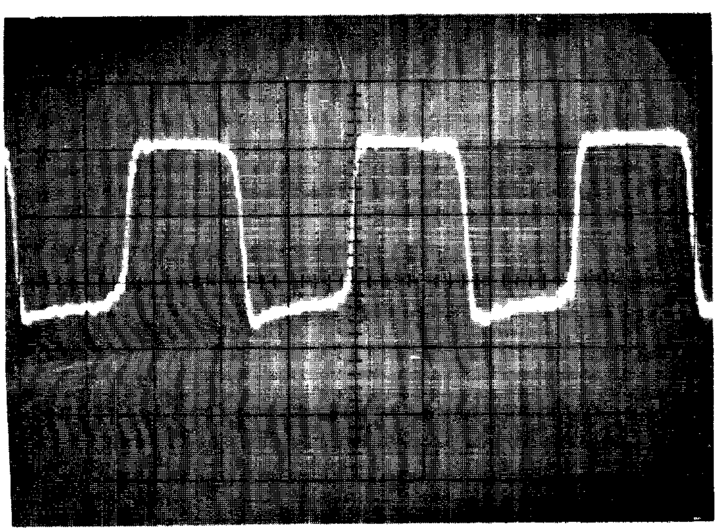
Table 5-6. Troubleshooting Procedure

CHECK	PROCEDURE	ACTION
1	Measure ac signal at junction of C413 and C415. Reading should be between 240 mv and 260 mv.	TRUE: Proceed to check 2. FALSE: Proceed to check 9.
2	Measure ac signal to Demodulator at positive end of C605. Refer to Figures 5-6 through 5-8.	TRUE: Proceed to check 3. FALSE: Proceed to check 6.



(Junction of C605 and V503)
3400A on 1 volt range with 1 volt input.
Scope (175A)
Sweep = 5 ms/cm
Vert = 0.2 volts/cm
Dc coupled (Center graticule = 0)

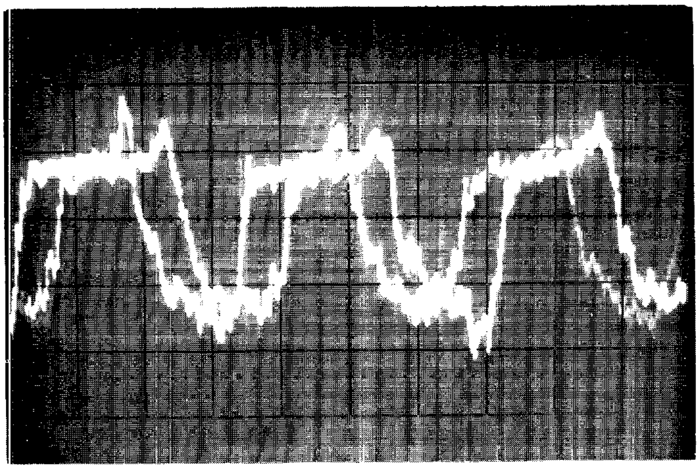
Figure 5-6. Input to Demodulator



(Junction of C605 and V503)
3400A on 1 volt range with 0.1 volt input.
Scope (175A)
Sweep = 5 ms/cm
Vert = 0.2 volts/cm
Dc coupled (Center graticule = 0)

Figure 5-7. Input to Demodulator

Table 5-6. Troubleshooting Procedure (Cont'd)



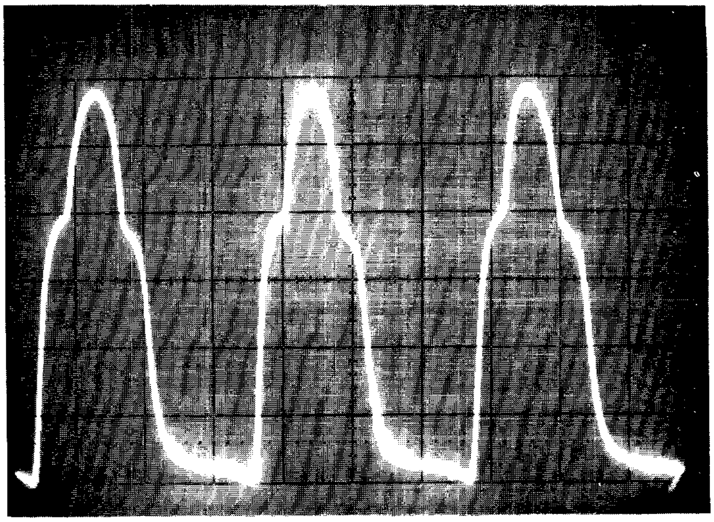
(Junction of C605 and V503)
No input; 3400A on 1. 0 v range.
Scope (175A)
Sweep 5 ms/cm
Vert = 0. 1 v/cm
Dc coupled
(Noise - caused by faulty chopper or Q605)

Figure 5-8. Input to Demodulator

CHECK	PROCEDURE	ACTION
3	Measure dc level at the base of Q604. Reading should be -0. 6 v for full-scale deflection.	TRUE: Proceed to check 4. FALSE: Proceed to check 5.
4	Investigate Emitter Follower.	a. Check dc values and component values listed in Figure 6-3. b. Check Q604 and Q605. c. Check C612. If this capacitor were slightly open, amplifier gain would be reduced and Q604 base voltage approaches zero. Voltage across C612 should be less than 300 μv peak-to-peak. d. If Q604 bias voltage is abnormal, check CR604.
5	Investigate Demodulator.	a. Observe Demodulator input on oscilloscope using LINE SYNC. At full-scale deflection, waveform should be negative. As deflection decreases to zero, waveform inverts, passing through zero at approximately one-half scale. Noise in Figure 5-8 caused by either faulty neons in chopper or Q605. Figure 5-13 is indicative of faulty chopper neon. b. Demodulator output should be proportional to ac input.
6	Measure the ac voltage at the positive side of C605 during slight overdrive conditions (1. 0 v input on 0. 3 v range). See Figure 5-9.	TRUE: Proceed to check 7. FALSE: Proceed to check 8.

Table 5-6. Troubleshooting Procedure (Cont'd)

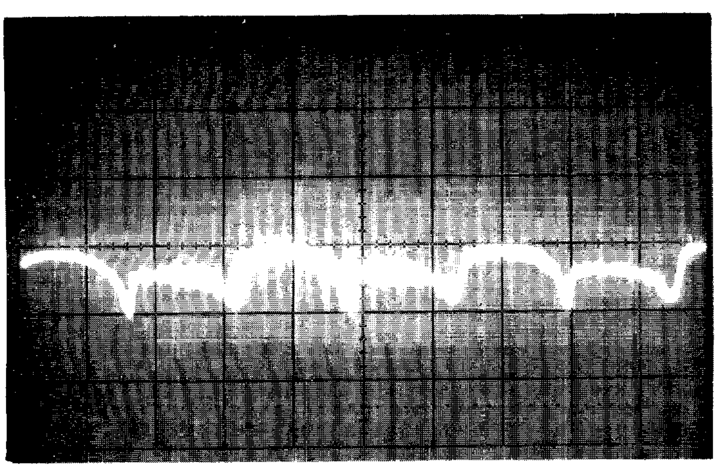
CHECK	PROCEDURE	ACTION



(Junction C605 and V503)
3400A on .3 v range with 1 v input.
Scope (175A)
Sweep = 5 ms/cm
Vert = 1 v/cm
Dc coupled

Figure 5-9. Demodulator Input (Overdriven)

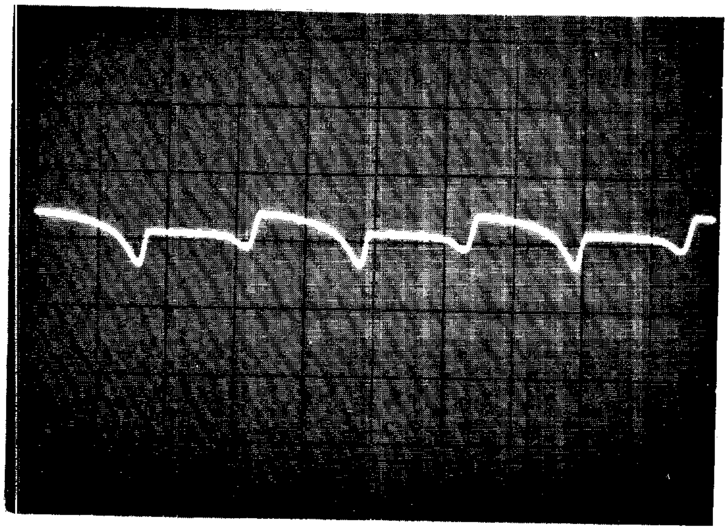
CHECK	PROCEDURE	ACTION
7	Investigate Demodulator output during normal and overdrive conditions. See Figures 5-10 and 5-11.	TRUE: Perform check 4; investigate feedback loops. FALSE: Perform check 5.



(BASE Q604)
3400A on 1 v range with 1 v input.
Scope (175A)
Sweep = 5 ms/cm
Vert = 0.1 v/cm
Dc coupled

Figure 5-10. Demodulator Output (Normal)

Table 5-6. Troubleshooting Procedure (Cont'd)

<table>
<tr><th>CHECK</th><th>PROCEDURE</th><th>ACTION</th></tr>
<tr><td colspan="2">
Figure 5-11. Demodulator Output (Overdriven)</td><td>(BASE Q604)
3400A on .3 v range with 1 v input.
Scope (175A)
Sweep = 5 ms/cm
Vert = 0.5 v/cm
Dc coupled</td></tr>
<tr><td>8</td><td>Investigate Modulator, Chopper Amplifier, and Thermocouples. See Figures 5-12 through 5-17.</td><td>a. Disconnect the base of Q604 from the chopper assembly (V503). Insert a dc signal, through a small resistor (1 K Ω), between the base of Q604 and chassis ground, to provide -0.6 v (+0.4 v for 1/10 scale deflection). The meter should indicate full-scale deflection. Trace the signal from the base of Q604, through the thermocouples, back to the modulator and through the chopper amplifier.

b. Should a defective modulator be suspected, break the line between pin 13 (A6) and V501. Apply a 10 mv dc signal through a 500 K resistor to V501. Check for a "chopped" waveform at the junction of V501 and V502. The modulated output should be proportional to input dc level at pin 13.

c. Figure 5-12 describes a proper neon voltage waveform. Figure 5-13 describes an improperly firing neon. Note negative voltage dip during conduction. Current variation through neon, following voltage waveform, causes noise as shown in Figure 5-8. For proper chopper action, neon firing potential (most negative point on waveform) is typically between 110 v and 120 v (never greater than 130 v). Jitter occurring on front panel meter may be seen at firing point or extinguishing point.

d. Check thermocouples and dc feedback from C608. Check thermocouples for open circuit or ground.</td></tr>
</table>

01768-1

Table 5-6. Troubleshooting Procedure (Cont'd)

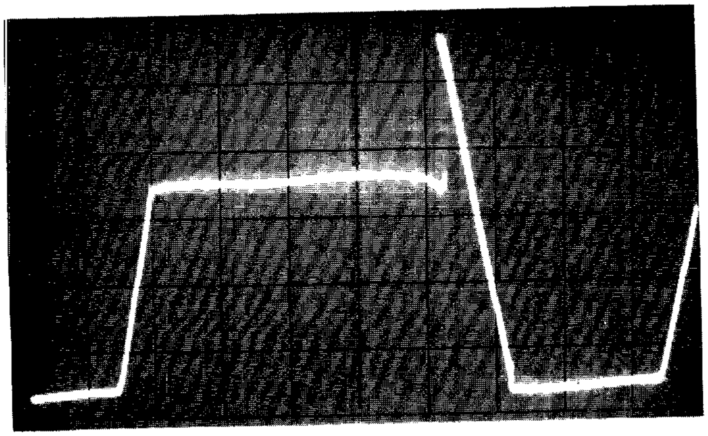


Figure 5-12
CHOPPER NEON VOLTAGE
(Pins 3 and 5, A6)
No input voltage to 3400A.
Scope (175A)
Sweep = 5 ms/cm
Vert = 20 v/cm
Dc coupled

Figure 5-12. Chopper Neon Voltage

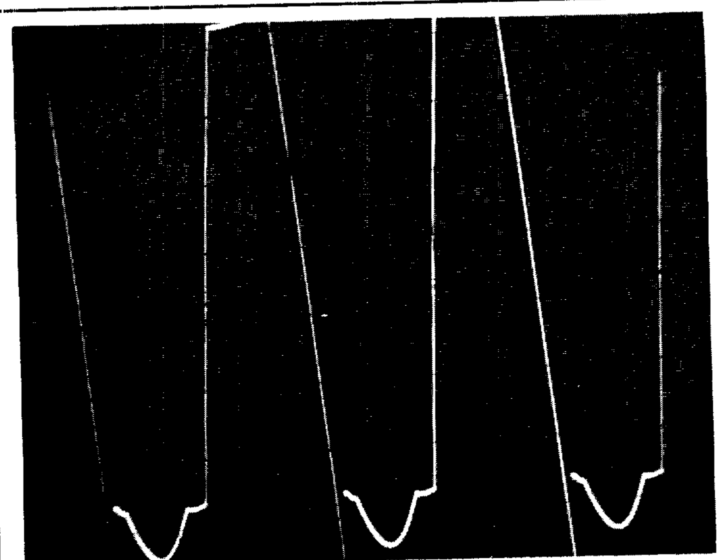


Figure 5-13
CHOPPER NEON VOLTAGE
(Pins 3 and 5, A6)
No input voltage to 3400A.
Scope (175A)
Sweep = 5 ms/cm
Vert = 10 v/cm
Dc coupled

Figure 5-13. Chopper Neon Voltage

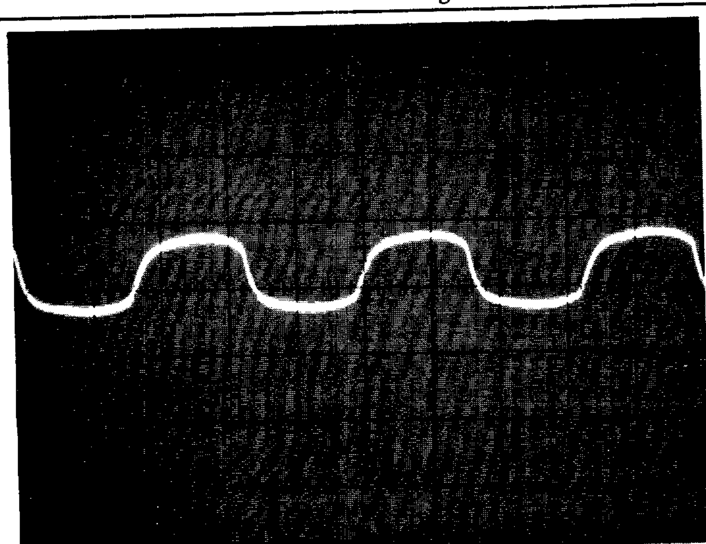


Figure 5-14
OUTPUT OF MODULATOR (OVER-DRIVEN)
Waveform taken at the junction of V501 and C601
3400A on 0.3 volt range with 1 v input.
Scope:
Sweep = 5 ms/cm
Vert 5 mv/cm

Figure 5-14. Output of Modulator (Overdriven)

Table 5-6. Troubleshooting Procedure (Cont'd)

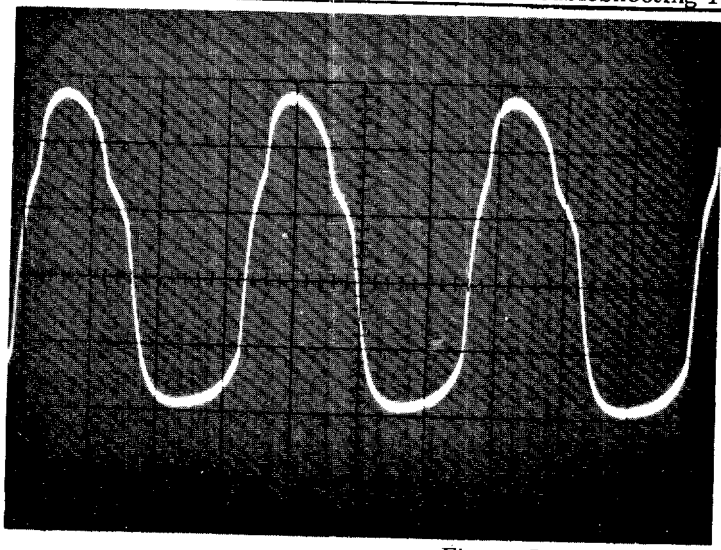


Figure 5-15
COLLECTOR OF Q601
3400A on 0.3 volt range with 1 v input.
Scope:
Sweep = 5 ms/cm
Vert = 5 mv/cm

Figure 5-15. Collector of Q601

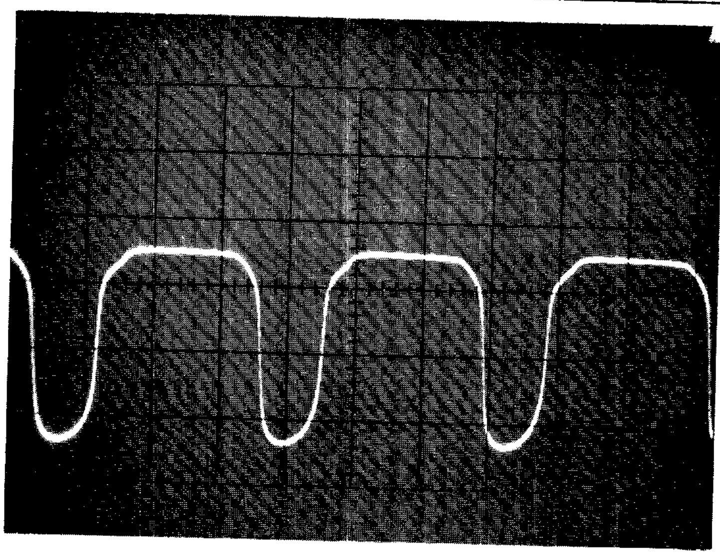


Figure 5-16
COLLECTOR OF Q602
3400A on 0.3 volt range with 1 v input.
Scope:
Sweep = 5 ms/cm
Vert = 0.2 v/cm

Figure 5-16. Collector of Q602

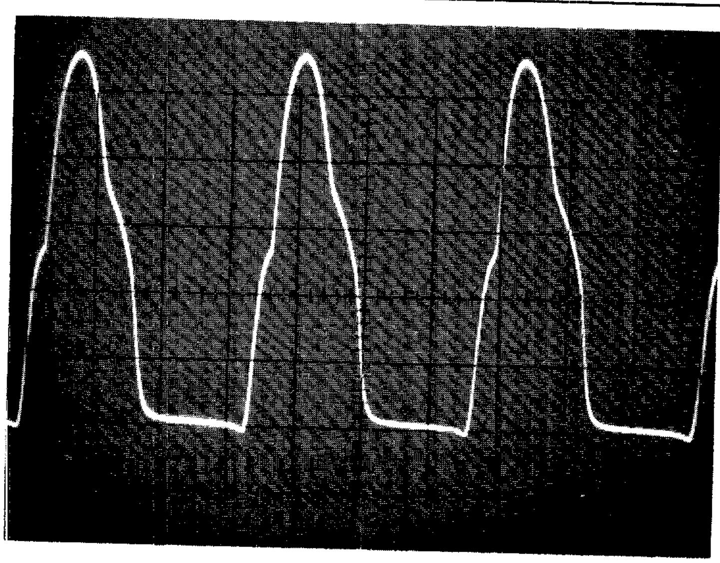


Figure 5-17
COLLECTOR OF Q603
3400A on 0.3 volt range with 1 v input.
Scope:
Sweep = 5 ms/cm
Vert = 2 v/cm

Figure 5-17. Collector of Q603

Table 5-6. Troubleshooting Procedure (Cont'd)

CHECK	PROCEDURE	ACTION
9	Measure ac signal to second Attenuator at negative end of C205. Reading should be between 0.90 mv and 1.0 mv.	TRUE: Proceed to check 10. FALSE: Proceed to check 13.
10	Measure ac signal to Amplifier (A4) at the positive side of C402. Reading should be 0.95 mv.	TRUE: Proceed to check 11. FALSE: Proceed to check 12.
11	Investigate Amplifier (A4).	a. Check ac voltage at the junction of C402 and Q401 (0.95 mv). b. Check C405. Although it is a high frequency adjustment, it can affect 400 cps calibration. This could affect 1 v tracking or cause excessive noise or oscillation. c. Amplifier gain can be checked using circled ac values in Figure 6-2. d. Check Q401 and Q402. If Q401 gain is low, check feedback loop through C411. e. If bias at Q405 or Q406 is abnormal, check CR401, 407, 408, and R419. Dc voltage at collector of Q406 should be -2 v ±0.5 v. R419 can be adjusted (0 to 350 ohms) in an effort to accomplish this. If the dc voltage is exceedingly high, check for shorted transistors or diodes.
12	Investigate Second Attenuator.	a. Check voltage at junction of C205 and R302. b. In six lower ranges, this voltage should equal the input signal (±5%). c. When replacing attenuator resistors, matched set must be utilized.
13	Investigate Input Attenuator and Impedance Converter.	a. Check R101 (10 M ±1/4%). b. On the higher six ranges, the input attenuator should appear as a 1000:1 divider. c. Check C102. d. Dc collector voltage at Q201 should not exceed 9.0 v, or switching transients will be introduced.

SECTION VI
CIRCUIT DIAGRAM

6-1. INTRODUCTION.

6-2. This section contains the circuit diagrams necessary for the operation and maintenance of the Model 3400A RMS Voltmeter. Included are schematic and parts location diagrams.

6-3. SCHEMATIC DIAGRAMS.

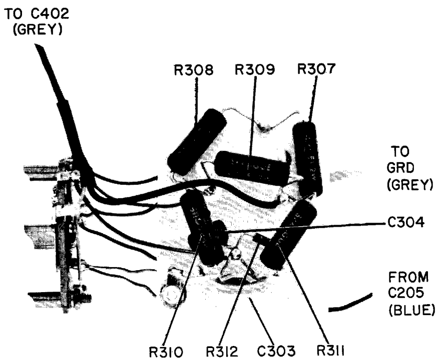
6-4. The schematic diagrams depict the circuits contained within each assembly of the 3400A as well as assembly interconnection. Main signal paths and significant feedback paths are identified.

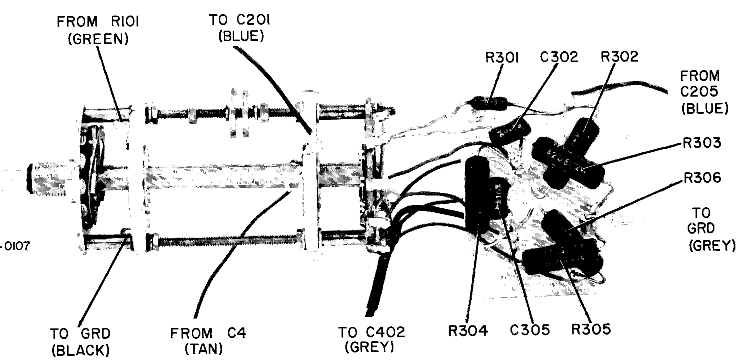
6-5. The schematic diagrams are arranged in ascending order of assembly reference designation.

6-6. PARTS LOCATION DIAGRAMS.

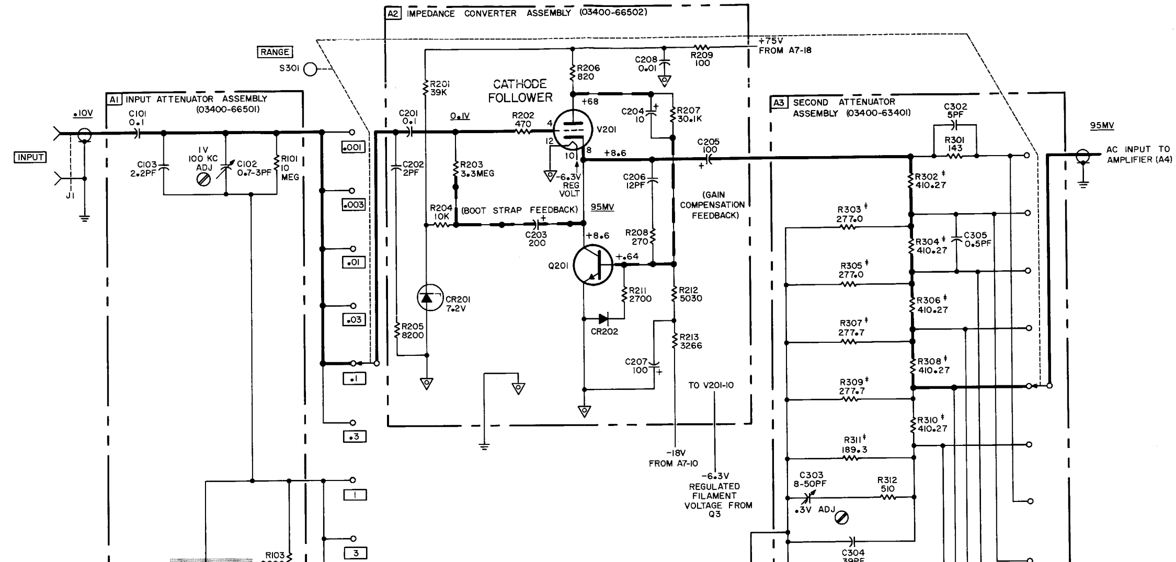
6-7. The parts location diagrams show the physical location of parts within an assembly. Parts are identified by reference designation. A parts location diagram is included for each assembly which does not have adequate silk screening of reference designations.

6-8. The parts location diagrams are located on the same figure as the schematic of the assembly.





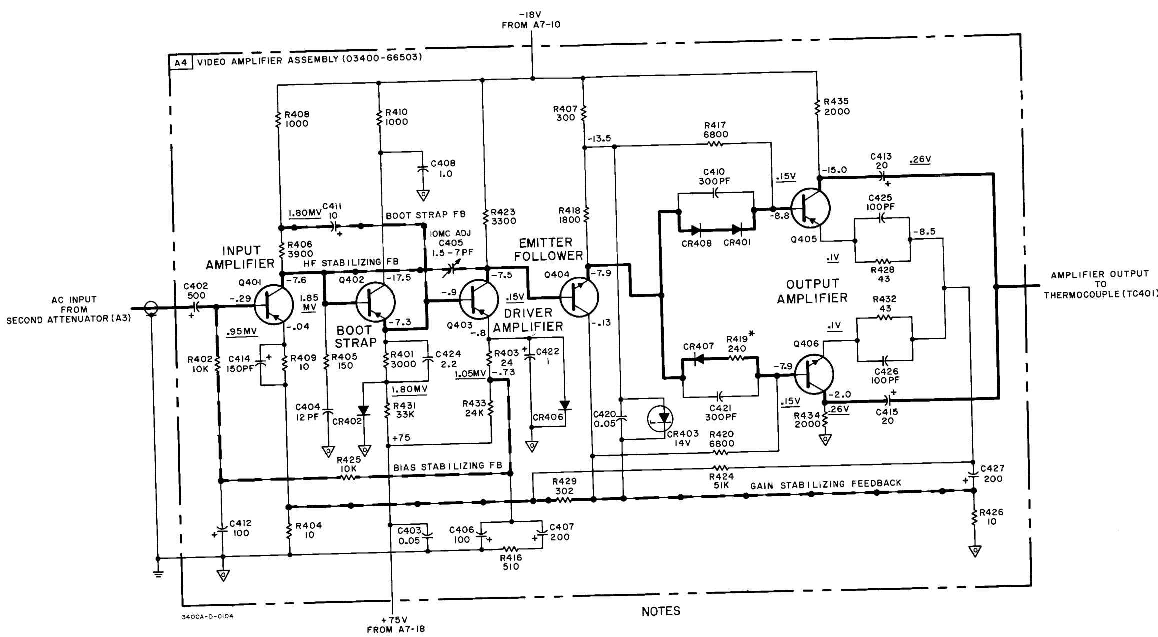
3400A-B-0107



NOTES

1. PRIMARY SIGNAL PATH.
   AC FEEDBACK PATH.
   DC FEEDBACK PATH.
2. PRIMARY SIGNAL PATH AND VOLTAGES ARE SHOWN WITH RANGE SWITCH IN THE .1 POSITION.
3. CABINET GROUND.
4. ▽ PRINTED CIRCUIT COMMON.
5. ‡ BRIDGE MATCHED RESISTOR, SEE PARTS LIST.
6. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS.
7. N AC VOLTAGE (INPUT = 0.1 V RMS).
8. ▭ DENOTES FRONT PANEL LOCATION.
9. COMPONENTS MOUNTED ON CHASSIS ARE SHADED.

Figure 6-1. Input Attenuator A1, Impedance Converter A2, and Second Attenuator A3 Schematic and Parts Location Diagram



NOTES

1. ———— PRIMARY SIGNAL PATH.
 —•—•— AC FEEDBACK PATH.
 — — — DC FEEDBACK PATH.
2. * OPTIMUM VALUE SELECTED AT FACTORY; AVERAGE VALUE SHOWN.
3. CABINET GROUND.
4. PRINTED CIRCUIT GROUND.
5. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS.
6. N AC VOLTAGE.

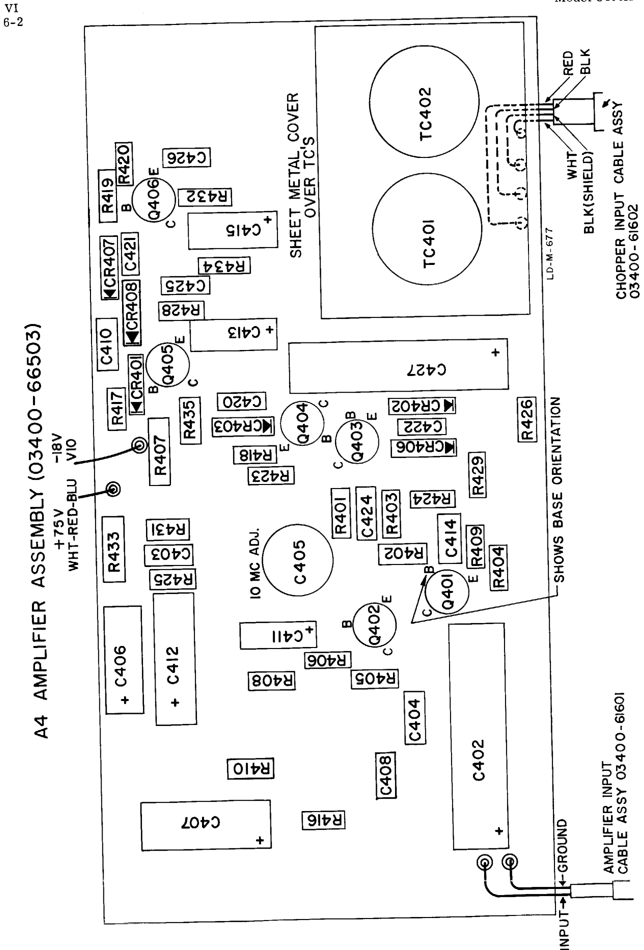


Figure 6-2. Video Amplifier A4 Schematic and Parts Location Diagram

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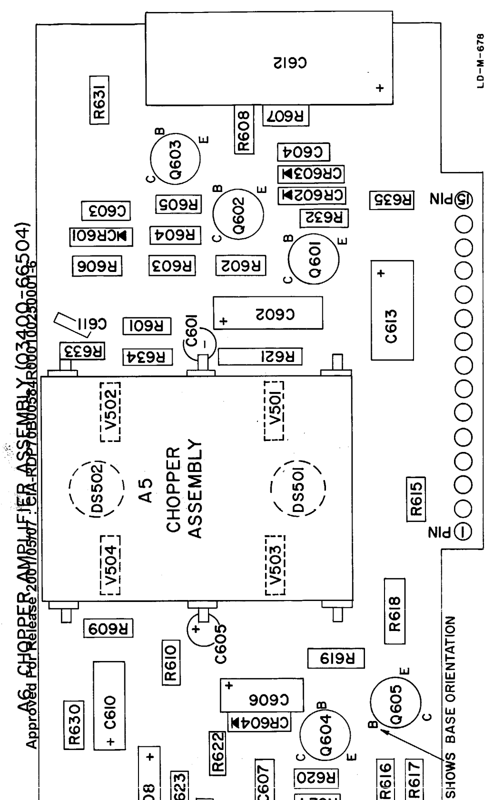

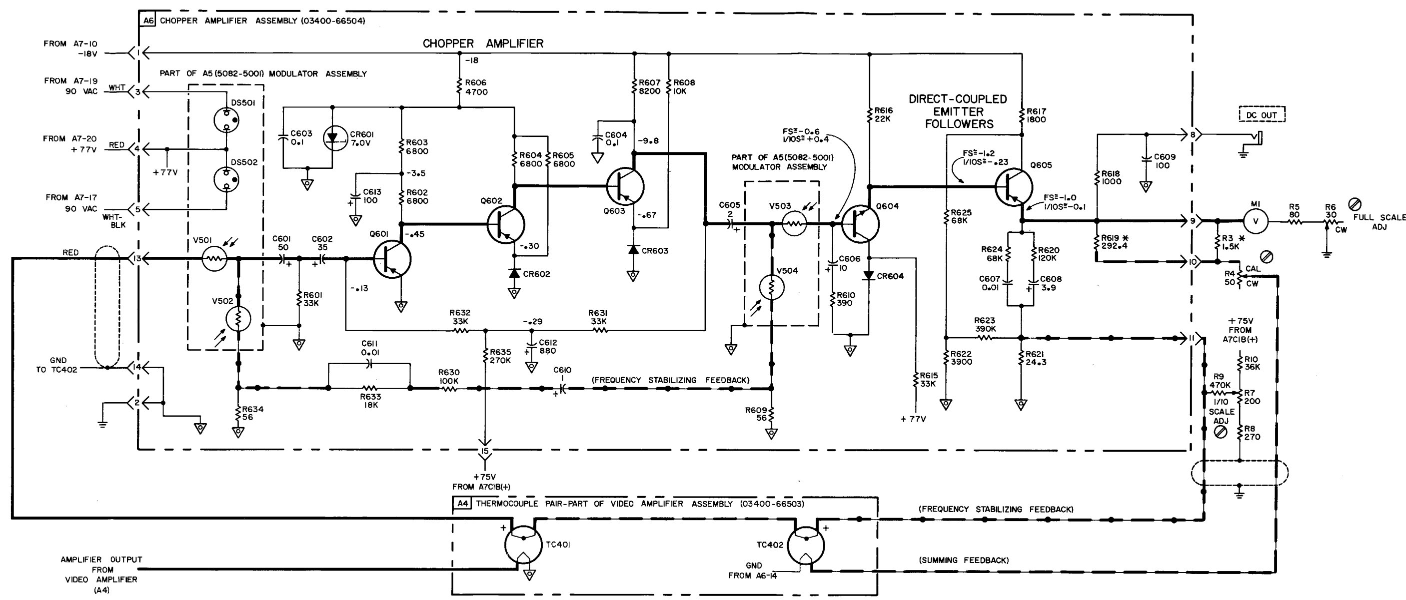

NOTES

1. PRIMARY SIGNAL PATH.
   AC FEEDBACK PATH.
   DC FEEDBACK PATH.
2. * OPTIMUM VALUE SELECTED AT FACTORY; AVERAGE VALUE SHOWN.
3. CABINET GROUND.
4. ▽ PRINTED CIRCUIT GROUND.
5. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS.
6. [-----] DENOTES REAR PANEL LOCATION.

Figure 6-3. Modulator/Demodulator A5, Chopper Amplifier A6, and Thermocouple Pair (Part of A4) Schematic and Parts Location Diagram

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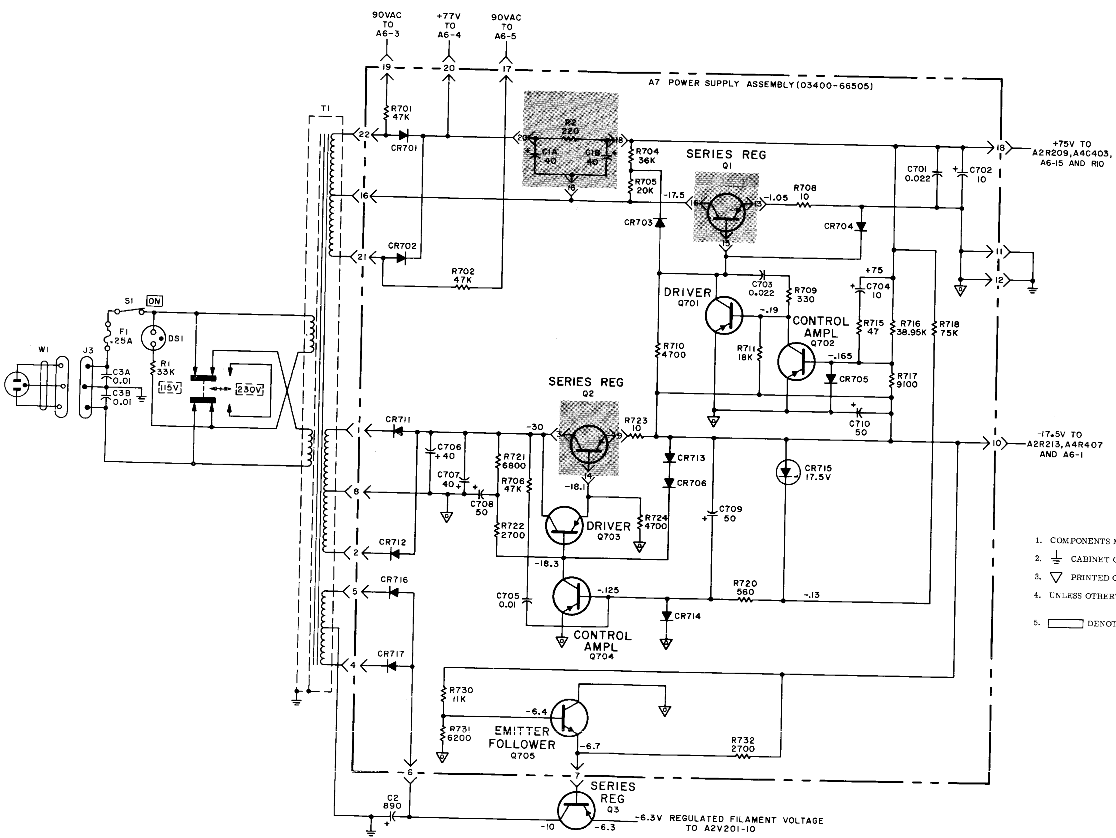

NOTES

1. COMPONENTS MOUNTED ON CHASSIS ARE SHADED.
2. ⏚ CABINET GROUND.
3. ▽ PRINTED CIRCUIT COMMON.
4. UNLESS OTHERWISE INDICATED: CAPACITANCE IN MICROFARADS, RESISTANCE IN OHMS.
5. ▭ DENOTES FRONT PANEL LOCATION.

Figure 6-4. Power Supply A7 Schematic Diagram

01768-1

SECTION VII

REPLACEABLE PARTS

7-1. INTRODUCTION.

7-2. This section contains information for ordering replacement parts. Table 7-1 lists parts in alpha-numerical order of their reference designators and indicates the description and ⓗⓟ stock number of each part, together with any applicable notes. Table 7-2 lists parts in alpha-numerical order of their ⓗⓟ stock number and provides the following information on each part:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code (see list of manufacturers in Appendix).

c. Manufacturer's part number.

d. Total quantity used in the instrument (TQ column).

7-3. Miscellaneous parts are listed at the end of Table 7-1.

7-4. ORDERING INFORMATION.

7-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office (see lists at rear of this manual for addresses). Identify parts by their Hewlett-Packard stock numbers.

7-6. NON-LISTED PARTS.

7-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor	FL	= filter	Q	= transistor	W	= cable
C	= capacitor	J	= jack	R	= resistor	X	= socket
CR	= diode	K	= relay	RT	= thermistor	XF	= fuseholder
DL	= delay line	L	= inductor	S	= switch	XDS	= lampholder
DS	= device signaling (lamp)	M	= meter	T	= transformer	Z	= network
E	= misc electronic part	MP	= mechanical part				

ABBREVIATIONS

a = amperes

bp = bandpass
bwo = backward wave oscillator

c = carbon
cer = ceramic
cmo = cabinet mount only
coef = coefficient
com = common
comp = composition
conn = connection
crt = cathode-ray tube

dep = deposited

EIA = Tubes or transistors meeting Electronic Industries' Association standards will normally result in instrument operating within specifications; tubes and transistors selected for best performance will be supplied if ordered by ⓗⓟ stock numbers.

elect = electrolytic
encap = encapsulated

f = farads
fxd = fixed

Ge = germanium
grd = ground (ed)

h = henries
Hg = mercury

impg = impregnated
incd = incandescent
ins = insulation (ed)

K = kilo = 1000

lin = linear taper
log = logarithmic taper

m = milli = 10^{-3}
M = megohms
ma = milliamperes
μ = micro = 10^{-6}
minat = miniature
mfgl = metal film on glass
mfr = manufacturer

mtg = mounting
my = mylar

NC = normally closed
Ne = neon
NO = normally open
NPO = negative positive zero (zero temperature coefficient)
nsr = not separately replaceable

obd = order by description

p = peak
pc = printed circuit board
pf = picofarads = 10^{-12} farads
pp = peak to peak
piv = peak inverse voltage
pos = position (s)
poly = polystyrene
pot = potentiometer
rect = rectifier

rot = rotary
rms = root-mean-square
rmo = rack mount only

s-b = slow-blow
Se = selenium
sect = section(s)
Si = silicon
sil = silver
sl = slide

td = time delay
TiO_2 = titanium dioxide

tog = toggle
tol = tolerance
trim = trimmer
twt = traveling wave tube

var = variable
w/ = with
W = watts
ww = wirewound
w/o = without

* = optimum value selected at factory, average value shown (part may be omitted)

Table 7-1. Reference Designation Index

REFERENCE DESIGNATION	ⓗⓟ PART NO.	DESCRIPTION	NOTE
A1	03400-66501	Ass'y: Input Attenuator Board	
A2	03400-66502	Ass'y: Impedance Converter Board	
A3	03400-63401	Ass'y: econd Attenuator	
A4	03400-66503	Ass'y: Amplifier Board	
A5	5082-5001	Ass'y: Photoconductor Chopper Part of A6	
A6	03400-66504	Ass'y: Chopper Amplifier Board	
A7	03400-66505	Ass'y: Power Supply Board	
C1	0180-0152	C: fxd, elect, 2X40 μf, 200 vdcw	
C2	0180-0148	C: fxd, alum, 890 μf -10% +100%, 15 vdcw	
C3A, B	0150-0119	C: fxd, cer, 2X.01μf ±20%, 250 vdcw	
C4	0160-0379	C: fxd, mica, 4775 pf ±10%, 500 vdcw	
C5 thru C100		Not Assigned	
C101	0170-0022	C: fxd, my, 0.1 μf ±20%, 600 vdcw	
C102	0132-0003	C: var, poly, 0.7 - 3.0 pf	
C103	0150-0058	C: fxd, cer, 2.2 pf, 600 vdcw	
C104 thru C200		Not Assigned	
C201	0170-0019	C: fxd, my, 0.1 μf ±5%, 200 vdcw	
C202	0150-0031	C: fxd, TI, 2 pf ±5%, 500 vdcw	
C203	0180-0060	C: fxd, elect, 200 μf -10% +100%, 3 vdcw	
C204	0180-0091	C: fxd, elect, 10 μf, 100 vdcw	
C205	0180-0039	C: fxd, elect, 100 μf, 12 vdcw	
C206	0140-0201	C: fxd, mica, 12 pf ±5%, 500 vdcw	
C207	0180-0061	C: fxd, elect, 100 μf -10% +100%, 15 vdcw	
C208	0150-0093	C: fxd, cer, 0.01 μf -20% +80%, 100 vdcw	
C209 thru C301		Not Assigned	
C302*	0160-0763	C: fxd, mica, 5 pf ±10%, 500 vdcw	
C303		Not Assigned	
C304	0140-0190	C: fxd, mica, 39 pf ±5%, 300 vdcw	
C305	0160-0763	C: fxd, mica, 5 pf ±10%, 500 vdcw	
C306 thru C401		Not Assigned	
C402	0180-0063	C: fxd, elect, 500 μf -10% +100%, 3 vdcw	
C403	0150-0096	C: fxd, cer, 0.05 μf, 100 vdcw	
C404	0140-0201	C: fxd, mica, 12 pf ±5%, 500 vdcw	
C405	0130-0018	C: var, cer, 1.5-7 pf, 500 vdcw	
C406	0180-0137	C: fxd, ta, elect, 100 μf ±20%, 10 vdcw	
C407	0180-0060	C: fxd, elect, 200 μf -10% +100%, 3 vdcw	
C408	0160-0127	C: fxd, cer, 1 μf ±20%, 25 vdcw	
C409		Not Assigned	
C410	0140-0225	C: fxd, mica, 300 pf ±1%, 300 vdcw	
C411	0180-0224	C: fxd, elect, 10 μf, 10 vdcw	
C412	0180-0039	C: fxd, elect, 100 μf, 12 vdcw	
C413	0180-0142	C: fxd, elect, 20 μf -10% +100%, 25 vdcw	
C414	0140-0196	C: fxd, mica, 150 pf ±5%, 300 vdcw	

See Appendix C
See introduction to this section

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	ⓗⓟ PART NO.	DESCRIPTION	NOTE
C415	0180-0142	C: fxd, elect, 20 μf -10% +100%, 25 vdcw	
C416 thru C419		Not Assigned	
C420	0150-0096	C: fxd, cer, 0.05 μf, 100 vdcw	
C421	0140-0225	C: fxd, mica, 300 pf ±1%, 300 vdcw	
C422	0160-0127	C: fxd, cer, 1 μf ±20%, 25 vdcw	
C423		Not Assigned	
C424	0160-0128	C: fxd, cer, 2.2 μf ±20%, 25 vdcw	
C425 and C426	0140-0176	C: fxd, mica, 100 pf ±2%, 300 vdcw	
C427	0180-0104	C: fxd, elect, 200 μf, 15 vdcw	
C428 thru C602		Not Assigned	
C603 and C604	0150-0084	C: fxd, cer, 0.1 μf -20% +80%, 50 vdcw	
C605	0180-0111	C: fxd, elect, 2 μf, 25 vdcw	
C606	0180-0224	C: fxd, elect, 10 μf, 10 vdcw	
C607	0150-0093	C: fxd, cer, 0.01 μf -20% +80%, 100 vdcw	
C608	0180-0022	C: fxd, elect, ta, 3.9 μfd, 35 vdcw	
C609	0180-0039	C: fxd, elect, 100 μf, 12 vdcw	
C610	0180-0119	C: fxd, elect, 1 μf -10 +100%, 25 vdcw	
C611	0150-0093	C: fxd, cer, 0.01 μf -20% +80%, 100 vdcw	
C612	0180-0156	C: fxd, alum, 880 μf -10% +100%, 1 vdcw	
C613	0180-0039	C: fxd, elect, 100 μf, 12 vdcw	
C614 thru C700		Not Assigned	
C701	0170-0024	C: fxd, my, 0.022 μf ±20%, 200 vdcw	
C702	0180-0089	C: fxd, elect, 10 μf -10% +100%, 150 vdcw	
C703	0170-0024	C: fxd, my, 0.022 μf ±20%, 200 vdcw	
C704	0180-0089	C: fxd, elect, 10 μf -10% +100%, 150 vdcw	
C705	0150-0012	C: fxd, cer, 0.01 μf ±20%, 1000 vdcw	
C706 and C707	0180-0050	C: fxd, elect, 40 μf -15% +100%, 50 vdcw	
C708 thru C710	0180-0105	C: fxd, elect, 50 μf, 25 vdcw	
CR201	1902-0045	Diode: avalanche, 7.32 v ±2%, 400 mw	
CR202	1901-0025	Diode: silicon, 100 piv	
CR203 thru CR400		Not Assigned	
CR401	1910-0016	Diode: germanium, 100 ma. 0.85 v	
CR402	1901-0040	Diode: silicon	
CR403	1902-0040	Diode: avalanche, 14 v ±5%, 400 mw	
CR404 and CR405		Not Assigned	
CR406	1901-0025	Diode: silicon, 100 piv	
CR407 and CR408	1910-0016	Diode: germanium, 100 ma, 0.85 v	

See introduction to this section

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	ℎ𝑝 PART NO.	DESCRIPTION	NOTE
CR409 thru CR600		Not Assigned	
CR601	1902-0046	Diode: breakdown, 7.15 v ±10%	
CR602	1910-0015	Diode: germanium, 50 ma, 30 piv	
CR603 and CR604	1901-0025	Diode: silicon, 100 piv	
CR605 thru CR700		Not Assigned	
CR701 and CR702	1901-0028	Diode: silicon, breakdown, 17.8 v ±2%, 400 mw	
CR703 thru CR706	1901-0025	Diode: silicon, 100 piv	
CR707 thru CR710		Not Assigned	
CR711 and CR712	1901-0026	Diode: silicon, 200 piv	
CR713 and CR714	1901-0025	Diode: silicon, 100 piv	
CR715	1902-0047	Diode: silicon, 0.5 amp, 400 piv	
CR716 and CR717	1901-0045	Diode: silicon, 100 piv	
DS1	1450-0048	Lamp: pilot, NE2H	
F1	2110-0004	Fuse: cartridge, 1/4 amp, 250 v	
J1	1250-0118	Connector: BNC	
J2	1251-0205	Jack: telephone, open circuit	
J3	1251-0148	Connector: power	
J4	1251-0208	Connector: PC, 22 contact	
J5	1251-0194	Connector: PC, 15 contact	
M1	1120-0320	Meter: full scale, 3 ma	
M1	1120-0308	Meter: DB only	
Q1	1850-0098	Transistor: germanium, PNP, selected	
Q2 and Q3	1850-0038	Transistor: germanium, PNP	
Q4 thru Q200		Not Assigned	
Q201	1854-0011	Transistor: Si, 2N835, NPN	
Q202 thru Q400		Not Assigned	
Q401 and Q402	1853-0007	Transistor: Si, 2N3251, PNP	
Q403	1850-0075	Transistor: germanium, 2N779A, PNP	
Q404	1854-0005	Transistor: Si, 2N708, PNP	
Q405	1850-0099	Transistor: germanium, 2N964	
Q406	1854-0005	Transistor: Si, 2N708, PNP	
Q407 thru Q600		Not Assigned	
Q601	1850-0060	Transistor: germanium, 2N383, PNP	
Q602	1850-0062	Transistor: germanium, PNP, selected	

Option 01
See introduction to this section

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	ⓗⓟ PART NO.	DESCRIPTION	NOTE
Q603	1850-0062	Transistor: germanium, PNP, selected	
Q604	1854-0033	Transistor: Si, 2N3391, PNP	
Q605	1853-0016	Transistor: germanium, 2N3638, PNP	
Q606 thru Q700		Not Assigned	
Q701 and Q702	1850-0062	Transistor: germanium, PNP, selected	
Q703 and Q704	1850-0040	Transistor: germanium, PNP, selected	
Q705	1851-0017	Transistor: germanium, NPN, 2N1304	
R1	0687-3331	R: fxd, comp, 33K ohms ±10%, 1/2 w	
R2		Not Assigned	
R3	0758-0017	R: fxd, met flm, 1500 ohms ±5%, 1/2 w	
R4	2100-0805	R: var, ww, lin, 50 ohms ±20%, 2 w	
R5	0812-0048	R: fxd, ww, 80 ohms ±3%, 1/2 w	
R6	2100-0721	R: var, ww, 30 ohms ±20%	
R7	2100-0412	R: var, ww, lin, 200 ohms ±20%, 2 w	
R8	0686-4315	R: fxd, comp, 430 ohms ±5%, 1/2 w	
R9	0684-4741	R: fxd, comp, 470K ohms ±10%, 1/4 w	
R10	0683-3635	R: fxd, comp, 36K ohms ±5%, 1/4 w	
R11 thru R100		Not Assigned	
R101	0760-0025	R: fxd, met flm 10 megohms ±1/4%, 1 w	
R102		Not Assigned	
R103	0721-0024	R: fxd, depc, 9.9K ohms ±5%, 1/8 w	
R104	2100-0128	R: var, comp, lin, 250 ohms ±20%, 1/3 w	
R105 thru R200		Not Assigned	
R201	0683-3935	R: fxd, comp, 39K ohms ±5%, 1/4 w	
R202	0683-4715	R: fxd, comp, 470 ohms ±5%, 1/4 w	
R203	0683-3355	R: fxd, comp, 3.3 megohms ±5%, 1/4 w	
R204	0683-1035	R: fxd, comp, 10K ohms ±5%, 1/4 w	
R205	0683-8225	R: fxd, comp, 8200 ohms ±5%, 1/4 w	
R206	0683-8215	R: fxd, comp, 820 ohms ±5%, 1/4 w	
R207	0727-0439	R: fxd, depc, 30.1K ohms ±1%	
R208	0683-2715	R: fxd, comp, 270 ohms ±5%, 1/4 w	
R209	0683-1015	R: fxd, comp, 100 ohms ±5%, 1/4 w	
R210		Not Assigned	
R211	0683-2725	R: fxd, comp, 2700 ohms ±5%, 1/4 w	
R212	0727-0136	R: fxd, depc, 5.03K ohms ±1%, 1/2 w	
R213	0727-0126	R: fxd, depc, 3.266K ohms ±1%, 1/2 w	
R214 thru R300		Not Assigned	
R301*	0757-0167	R: fxd, flm, 143 ohms ±1%, 0.125 w	
R302 thru R311	03400-62602	Resistors: fxd, ww, matched set	
R312	0683-5115	R: fxd, comp, 510 ohms ±5%, 1/4 w	

See introduction to this section

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	℔ PART NO.	DESCRIPTION	NOTE
R313 thru R400		Not Assigned	
R401	0683-3025	R: fxd, comp, 3000 ohms ±5%, 1/4 w	
R402	0683-1035	R: fxd, comp, 10K ohms ±5%, 1/4 w	
R403	0683-2405	R: fxd, comp, 24 ohms ±5%, 1/4 w	
R404	0757-0346	R: fxd, met ox, 10 ohms ±1%, 1/8 w	
R405	0683-1515	R: fxd, comp, 150 ohms ±5%, 1/4 w	
R406	0683-3925	R: fxd, comp, 3900 ohms ±5%, 1/4 w	
R407	0727-0065	R: fxd, depc, 90.5K ohms ±1%, 1 w	
R408	0683-1025	R: fxd, comp, 1000 ohms ±5%, 1/4 w	
R409	0683-1005	R: fxd, comp, 10 ohms ±5%, 1/4 w	
R410	0683-1025	R: fxd, comp, 1000 ohms ±5%, 1/4 w	
R411 thru R415		Not Assigned	
R416	0683-5115	R: fxd, comp, 510 ohms ±5%, 1/4 w	
R417	0683-6825	R: fxd, comp, 6800 ohms ±5%, 1/4 w	
R418	0683-1825	R: fxd, comp, 1800 ohms ±5%, 1/4 w	
R419	0683-2415	R: fxd, comp, 240 ohms ±5%, 1/4 w Factory selected comp: typical value given	
R420	0683-6825	R: fxd, comp, 6800 ohms ±5%, 1/4 w	
R421 and R422		Not Assigned	
R423	0683-3325	R: fxd, comp, 3300 ohms ±5%, 1/4 w	
R424	0683-5135	R: fxd, comp, 51K ohms ±5%, 1/4 w	
R425	0683-1035	R: fxd, comp, 10K ohms ±5%, 1/4 w	
R426 and R427	0757-0162	R: fxd, met ox, 20 ohms ±1%, 1/8 w	
R428	0683-4305	R: fxd, comp, 43 ohms ±5%, 1/4 w	
R429	0757-0345	R: fxd, met ox, 302 ohms ±1%, 1/8 w	
R430		Not Assigned	
R431	0683-3335	R: fxd. comp, 33K ohms ±5%, 1/4 w	
R432	0683-4305	R: fxd. comp,43 ohms ±5%, 1/4 w	
R433	0758-0073	R: fxd, met flm, 24K ohms ±5%, 1/2 w	
R434 and R435	0758-0033	R: fxd, met flm, 2000 ohms ±5%, 1/2 w	
R436 thru R600		Not Assigned	
R601	0683-3335	R: fxd, comp, 33K ohms ±5%, 1/4 w	
R602 thru R605	0683-6825	R: fxd, comp, 6800 ohms ±5%, 1/4 w	
R606	0683-4725	R: fxd, comp, 4700 ohms ±5%, 1/4 w	
R607	0683-8225	R: fxd, comp, 8200 ohms ±5%, 1/4 w	
R608	0683-1035	R: fxd, comp, 10K ohms ±5%, 1/4 w	
R609	0683-5605	R: fxd, comp, 56 ohms ±5%, 1/4 w	
R610	0683-3915	R: fxd, comp, 390 ohms ±5%, 1/4 w	
R611 thru R614		Not Assigned	
R615	0683-3335	R: fxd, comp, 33K ohms ±5%, 1/4 w	
R616	0683-2235	R: fxd, comp, 22K ohms ±5%, 1/4 w	
R617	0758-0043	R: fxd, met flm,1400 ohms ±5%, 1/2 w	
R618	0727-0100	R: fxd, depc, 1000 ohms ±1%, 1/2 w	
R619	0727-0063	R: fxd, depc, 292.4 ohms ±1%, 1/2 w	

℔ See introduction to this section

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	ⓗ PART NO.	DESCRIPTION	NOTE
R620	0683-1245	R: fxd, comp, 120K ohms ±5%, 1/4 w	
T621	0727-0013	R: fxd, depc, 24.3 ohms ±1%, 1/2 w	
R622	0683-3925	R: fxd, comp, 3900 ohms ±5%, 1/4 w	
R623	0683-3945	R: fxd, comp, 390K ohms ±5%, 1/4 w	
R624	0683-6835	R: fxd, comp, 68K ohms ±5%, 1/4 w	
R625	0758-0076	R: fxd, met flm, 68K ohms ±5%, 1/2 w	
R626 thru R629		Not Assigned	
R630	0683-1045	R: fxd, comp, 100K ohms ±5%, 1/4 w	
R631 and R632	0683-3335	R: fxd, comp, 33K ohms ±5%, 1/4 w	
R633	0683-1835	R: fxd, comp, 18K ohms ±5%, 1/4 w	
R634	0683-5605	R: fxd, comp, 56 ohms ±5%, 1/4 w	
R635	0683-2745	R: fxd, comp, 270K ohms ±5%, 1/4 w	
R636 thru R700		Not Assigned	
R701 and R702	0693-4731	R: fxd, comp, 47K ohms ±10%, 2 w	
R703	0687-2211	R: fxd, comp, 220 ohms ±10%, 1/2 w	
R704	0758-0064	R: fxd, met flm, 36K ohms ±5%, 1/2 w	
R705	0683-2035	R: fxd, comp, 20K ohms ±5%, 1/4 w	
R706	0683-4735	R: fxd, comp, 47K ohms ±5%, 1/4 w	
R707		Not Assigned	
R708	0683-1005	R: fxd, 10 ohms ±5%, 1/4 w	
R709	0683-3315	R: fxd, comp, 330 ohms ±5%, 1/4 w	
R710	0683-4725	R: fxd, comp, 4700 ohms ±5%, 1/4 w	
R711	0687-1831	R: fxd, comp, 18K ohms ±10%, 1/2 w	
R712 thru R714		Not Assigned	
R715	0683-4705	R: fxd, comp, 47 ohms ±5%, 1/4 w	
R716	0727-0188	R: fxd, depc, 38.9K ohms ±1/2%, 1/2 w	
R717	0727-0153	R: fxd, depc, 9.1K ohms ±1%, 1/2 w	
R718	0683-7535	R: fxd, comp, 75K ohms ±5%, 1/4 w	
R719		Not Assigned	
R720	0683-5615	R: fxd, comp, 560 ohms ±5%, 1/4 w	
R721	0683-6825	R: fxd, comp, 6800 ohms ±5%, 1/4 w	
R722	0683-2725	R: fxd, comp, 2700 ohms ±5%, 1/4 w	
R723	0684-1001	R: fxd, comp, 10 ohms ±10%, 1/4 w	
R724	0683-4725	R: fxd, comp, 4700 ohms ±5%, 1/4 w	
R725 thru R729		Not Assigned	
R730	0683-1135	R: fxd, comp, 11K ohms ±5%, 1/4 w	
R731	0683-6225	R: fxd, comp, 6200 ohms ±5%, 1/4 w	
R732	0683-2725	R: fxd, comp, 2700 ohms ±5%, 1/4 w	
S1	3101-0036	Switch: toggle, SPST, 3 amp, 250 v	
S2	3101-0033	Switch: slide	
S3 thru S300		Not Assigned	
S301	3100-0358	Switch: rotary, 3 sect, 12 pos	
T1	9100-0171	Transformer: power	
TC401 and TC402	03400-82801	Thermocouples -- matched pair	

See introduction to this section

Table 7-1. Reference Designation Index (Cont'd)

REFERENCE DESIGNATION	ℎ𝑝 PART NO.	DESCRIPTION	NOTE
V201	1921-0017	Electron Tube: 7586 nuvistor triode	
W1	8120-0078	Power Cord, 7-1/2 ft.	
XF1	1400-0084	Fuseholder: extractor, post-type, 2-5/64 inches long	
XV201	1200-0086	Socket: nuvistor, 5-pin	
		MISCELLANEOUS	
	0370-0077	Knob: bar (with one arrow)	
	1200-0043	Insulator: transistor anodized aluminum	
	1200-0081	Insulator: transistor, nylon, .235 in. od.	
	1490-0031	Stand: tilt	
	1520-0002	Plate: capacitor mounting	
	1520-0003	Plate: capacitor mounting	
	5000-0703	Cover: side	
	5000-0711	Cover: bottom	
	5060-0706	Cover Ass'y: top	
	5060-0727	Foot Ass'y	
	03400-01202	Clamp: capacitor mounting	
	03400-01204	Bracket: ground	
	03400-61601	Cable Ass'y: Amplifier Input	
	03400-61602	Cable Ass'y: Chopper Input	
	03400-61603	Cable Ass'y: Input Attenuator	
	03400-69501	Shock mount impedance converter	
	3400A-902	Manual: Operating and Service	

See introduction to this section

Table 7-2. Replaceable Parts

ⓗ PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
0130-0018	C: var, cer, 1.5-7 pf, 500 vdcw	72982	557-019-C0P0-10R	1	
0132-0003	C: var, poly, 0.7-3.0 pf	72982	535-016-4R	1	
0140-0176	C: fxd, mica, 100 pf ±2%, 300 vdcw	04062	DM15F101G 300V	2	
0140-0190	C: fxd, mica, 39 pf ±5%, 300 vdcw	04062	DM15E390J 300V	1	
0140-0196	C: fxd, mica, 150 pf ±5%, 300 vdcw	04062	DM15F151J 300V	1	
0140-0201	C: fxd, mica, 12 pf ±5%, 500 vdcw	04062	DM15C120J	2	
0140-0225	C: fxd, mica, 300 pf ±1%, 300 vdcw	04062	DM15F301F 300V	2	
0150-0012	C: fxd, cer, 0.01 μf ±20%, 1000 vdcw	56289	H 1038	1	
0150-0031	C: fxd, TiO_2, 2 pf ±5%, 500 vdcw	78488	Type GA 2PF 5%	1	
0150-0058	C: fxd, cer, 2.2 pf, 600 vdcw	72982	301 000 C0J0 229C	1	
0150-0084	C: fxd, cer, 0.1 μf +80% -20%, 50 vdcw	56289	33C41	2	
0150-0093	C: fxd, cer, 0.01 μf +80% -20%, 100 vdcw	91418	TA	3	
0150-0096	C: fxd, cer, 0.05 μf, 100 vdcw	91418	TA	2	
0150-0119	C: fxd, cer, 2X .01 μf ±20%, 250 vdcw	71590	DA17004CD	1	
0160-0127	C: fxd, cer, 1 μf ±20%, 25 vdcw	56289	5C13	2	
0160-0128	C: fxd, cer, 2.2 μf ±20%, 25 vdcw	56289	5C13	1	
0160-0379	C: fxd, mica, 4775 pf ±10%, 500 vdcw	72982	633-010	1	
0160-0763	C: fxd, mica, 5 pf ±10%, 500 vdcw	00853	obd#	2	
0170-0019	C: fxd, my, 0.1 μf ±5%, 200 vdcw	28480	0170-0019	1	
0170-0022	C: fxd, my, 0.1 μf ±20%, 600 vdcw	09134	Type 27	1	
0170-0024	C: fxd, my, 0.022 μf ±20%, 200 vdcw	56289	192P22302	2	
0180-0022	C: fxd, elect, ta, 3.9 μf, 35 vdcw	05397	K3R9J35KS	1	
0180-0039	C: fxd, elect, 100 μf, 12 vdcw	56289	30D154A1	4	
0180-0050	C: fxd, elect, 40 μf +100% -15%, 50 vdcw	56289	D32538	2	
0180-0060	C: fxd, elect, 200 μf +100% -10%, 3 vdcw	56289	30D116A1	2	
0180-0061	C: fxd, elect, 100 μf +100% -10%, 15 vdcw	56289	30D172A1	1	
0180-0063	C: fxd, elect, 500 μf +100% -10%, 3 vdcw	56289	30D120A1	1	
0180-0064	C: fxd, elect, 35 μf +100% -10%, 6 vdcw	56289	30D132A1	1	
0180-0081	C: fxd, elect, ta, 50 μf +20% -15%, 10 vdcw	10411	MTA-50-10	1	
0180-0089	C: fxd, elect, 10 μf +100% -10%, 150 vdcw	56289	30D218A1	2	
0180-0091	C: fxd, elect, 10 μf, 100 vdcw	56289	30D208A1	1	
0180-0104	C: fxd, elect, 200 μf, 15 vdcw	56289	30D174A1	1	
0180-0105	C: fxd, elect, 50 μf, 25 vdcw	56289	S97441	3	
0180-0111	C: fxd, elect, 2 μf, 25 vdcw	56289	40D173A2	1	
0180-0119	C: fxd, elect, 1 μf +100% -10%, 25 vdcw	56289	30D175A1	1	
0180-0137	C: fxd, elect, ta, 100 μf ±20%, 10 vdcw	56289	150D107X0010R2	1	
0180-0142	C: fxd, elect, 20 μf +100% -10%, 25 vdcw	56289	Type 40D	2	
0180-0148	C: fxd, alum, 890 μf +100% -10%, 15 vdcw	00853	Type PL1	1	
0180-0152	C: fxd, elect, 2X40 μf, 200 vdcw	28480	0180-0152	1	
0180-0156	C: fxd, alum, 880 μf, +100% -10%, 1 vdcw	56289	Type 34D	1	
0180-0224	C: fxd, elect, 10 μf +75% -10%, 15 vdcw	56289	30D106G015BA4	2	
0370-0077	Knob: bar (with one arrow)	28480	0370-0077	1	
0683-1005	R: fxd, comp, 10 ohms ±5%, 1/4 w	01121	CB1005	2	
0683-1015	R: fxd, comp, 100 ohms ±5%, 1/4 w	01121	CB1015	1	
0683-1025	R: fxd, comp, 1000 ohms ±5%, 1/4 w	01121	CB1025	2	
0683-1035	R: fxd, comp, 10K ohms ±5%, 1/4 w	01121	CB1035	4	
0683-1045	R: fxd, comp, 100K ohms ±5%, 1/4 w	01121	CB1045	1	

See introduction to this section

Table 7-2. Replaceable Parts (Cont'd)

ⓗ PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
0683-1135	R: fxd, comp, 11K ohms ±5%, 1/4 w	01121	CB1135	1	
0683-1245	R: fxd, comp, 120K ohms ±5%, 1/4 w	01121	CB1245	1	
0683-1515	R: fxd, comp, 150 ohms ±5%, 1/4 w	01121	CB1515	1	
0683-1825	R: fxd, comp, 1800 ohms ±5%, 1/4 w	01121	CB1825	1	
0683-1835	R: fxd, comp, 18K ohms ±5%, 1/4 w	01121	CB1835	1	
0683-2035	R: fxd, comp, 20K ohms ±5%, 1/4 w	01121	CB2035	1	
0683-2235	R: fxd, comp, 22K ohms ±5%, 1/4 w	01121	CB2235	1	
0683-2405	R: fxd, comp, 24 ohms ±5%, 1/4 w	01121	CB2405	1	
0683-2415	R: fxd, comp, 240 ohms ±5%, 1/4 w	01121	CB2415	1	
0683-2715	R: fxd, comp, 270 ohms ±5%, 1/4 w	01121	CB2715	1	
0683-2725	R: fxd, comp, 2700 ohms ±5%, 1/4 w	01121	CB2725	3	
0683-2745	R: fxd, comp, 270K chms ±5%, 1/4 w	01121	CB2745	1	
0683-3025	R: fxd, comp, 3000 ohms ±5%, 1/4 w	01121	CB3025	1	
0683-3315	R: fxd, comp, 330 ohms ±5%, 1/4 w	01121	CB3315	1	
0683-3325	R: fxd, comp, 3300 ohms ±5%, 1/4 w	01121	CB3325	1	
0683-3335	R: fxd, comp, 33K ohms ±5%, 1/4 w	01121	CB3335	5	
0683-3355	R: fxd, comp, 3.3 megohms ±5%, 1/4 w	01121	CB3355	1	
0683-3635	R: fxd, comp, 36K ohms ±5%, 1/4 w	01121	CB3635	1	
0683-3915	R: fxd, comp, 390 ohms ±5%, 1/4 w	01121	CB3915	1	
0683-3925	R: fxd, comp, 3900 ohms ±5%, 1/4 w	01121	CB3925	2	
0683-3935	R: fxd, comp, 39K ohms ±5%, 1/4 w	01121	CB3935	1	
0683-3945	R: fxd, comp, 390K ohms ±5%, 1/4 w	01121	CB3945	1	
0683-4305	R: fxd, comp, 43 ohms ±5%, 1/4 w	01121	CB4305	2	
0683-4705	R: fxd, comp, 4.7 ohms ±5%, 1/4 w	01121	CB4705	2	
0683-4715	R: fxd, comp, 470 ohms ±5%, 1/4 w	01121	CB4715	1	
0683-4725	R: fxd, comp, 4700 ohms ±5%, 1/4 w	01121	CB4725	3	
0683-4735	R: fxd, comp, 47K ohms ±5%, 1/4 w	01121	CB4735	1	
0683-5115	R: fxd, comp, 510 ohms ±5%, 1/4 w	01121	CB5115	2	
0683-5135	R: fxd, comp, 51K ohms ±5%, 1/4 w	01121	CB5135	1	
0683-5605	R: fxd, comp, 56 ohms ±5%, 1/4 w	01121	CB5605	2	
0683-5615	R: fxd, comp, 560 ohms ±5%, 1/4 w	01121	CB5615	1	
0683-6225	R: fxd, comp, 6200 ohms ±5%, 1/4 w	01121	CB6225	1	
0683-6825	R: fxd, comp, 6800 ohms ±5%, 1/4 w	01121	CB6825	7	
0683-6835	R: fxd, comp, 68K ohms ±5%, 1/4 w	01121	CB6835	1	
0683-7535	R: fxd, comp, 75K ohms ±5%, 1/4 w	01121	CB7535	1	
0683-8215	R: fxd, comp, 820 ohms ±5%, 1/4 w	01121	CB8215	1	
0683-8225	R: fxd, comp, 8200 ohms ±5%, 1/4 w	01121	CB8225	2	
0684-1001	R: fxd, comp, 10 ohms ±10%, 1/4 w	01121	CB1001	1	
0684-4741	R: fxd, comp, 470 K ohms ±10%, 1/4 w	01121	CB4741	1	
0686-4315	R: fxd, comp, 430 ohms ±5%, 1/2 w	01121	EB4315	1	
0687-1831	R: fxd, comp, 18K ohms ±10%, 1/2 w	01121	EB1831	1	
0687-2211	R: fxd, comp, 220 ohms ±10%, 1/2 w	01121	EB2211	1	
0687-3331	R: fxd, comp, 33K ohms ±10%, 1/2 w	01121	EB3331	1	
0693-4731	R: fxd, comp, 47K ohms ±10%, 2 w	01121	HB4731	2	
0721-0024	R: fxd, depc, 9.9K ohms ±5%, 1/8 w	19701	DCM 1/8	1	
0727-0013	R: fxd, depc, 24.3 ohms ±1%, 1/2 w	19701	DC1/2CR5	1	
0727-0063	R: fxd, depc, 292.4 ohms ±1%, 1/2 w	19701	DC1/2C	1	
0727-0065	R: fxd, depc, 90.5K ohms ±1%, 1 w	19701	DC1 R5	1	

See introduction to this section

Table 7-2. Replaceable Parts (Cont'd)

PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
0727-0100	R: fxd, depc, 1000 ohms ±1%, 1/2 w	19701	DC1/2CR5	1	
0727-0126	R: fxd, depc, 3.266K ohms ±1%, 1/2 w	19701	DC1/2AR5	1	
0727-0136	R: fxd, depc, 5.03K ohms ±1%, 1/2 w	19701	DC1/2CR5	1	
0727-0153	R: fxd, depc, 9.1K ohms ±1%, 1/2 w	19701	DC1/2CR5	1	
0727-0188	R: fxd, depc, 38.95K ohms ±1/2%, 1/2 w	19701	DC1/2AR5	1	
0757-0345	R: fxd, met flm, 302 ohms ±1%, 1/8 w	19701	N60	1	
0757-0346	R: fxd, met flm, 10.0 ohms ±1%, 1/8 w	19701	MF5CT-0	1	
0757-0162	R: fxd, met ox, 20 ohms ±1%, 1/8 w	07115	N60	3	
0757-0167	R: fxd, flm, 143 ohms ±1%, 0.125 w	19701	MF1/8 T0	1	
0758-0017	R: fxd, met flm, 1500 ohms ±5%, 1/4 w	07115	C20	1	
0758-0023	R: fxd, met flm, 240 ohms ±5%, 1/2 w	07115	C20	1	
0758-0033	R: fxd, met flm, 2000 ohms ±5%, 1/2 w	07115	C20	2	
0758-0043	R: fxd, met flm, 1400 ohms ±5%, 1/2 w	07115	C20	1	
0758-0064	R: fxd, met flm, 36K ohms ±5%, 1/2 w	07115	C20	1	
0758-0073	R: fxd, met flm, 24K ohms ±5%, 1/2 w	07115	C20	1	
0758-0076	R: fxd, met flm, 68K ohms ±5%, 1/2 w	07115	C20	1	
0760-0025	R: fxd, met flm, 10 megohms ±1/4%, 1 w	03888	Type PT 1000	1	
0812-0048	R: fxd, ww, 80 ohms ±3%, 1/2 w	14193	SA10	1	
> 1120-0308	Meter: DB only	28480	1120-0308	1	
1120-0320	Meter: full scale, 3 ma	28480	1120-0320	1	
1200-0043	Insulator: transistor, anodized aluminum	76530	294457	1	
1200-0081	Insulator: transistor, nylon, .235 in. od.	26365	974	1	
1200-0086	Socket: nuvistor, 5-pin	71785	1336510009	1	
1250-0118	Connector: BNC	91737	8427	1	
1251-0148	Connector: power	0000U	H-10611G-3L	1	
1251-0194	Connector: P.C., 15-contact	95354	SD-615TS	1	
1251-0205	Jack: telephone, open circuit	82389	2J-1432	1	
1251-0208	Connector: P.C., 22-contact	95354	SD-622UR	1	
1400-0084	Fuseholder: extractor, post-type, 2-5/64 inches long	75915	342014	1	
1450-0048	Lamp: pilot, NE2H	08717	858R	1	
1490-0031	Stand: tilt	91260	obd#	1	
1850-0038	Transistor: germanium, PNP	86684	1850-0038	2	
1850-0040	Transistor: germanium, 2N383	86684	1850-0040	1	
1850-0060	Transistor: germanium, PNP, 2N383	86684	3748	1	
1850-0062	Transistor: germanium, PNP, selected	28480	1850-0062	5	
1850-0075	Transistor: germanium, PNP, 2N779A	87216	2N779A	1	
1850-0098	Transistor: germanium, PNP, selected	28480	1850-0098	1	
1850-0099	Transistor: germanium, PNP, 2N964	04713	2N964	1	
1851-0017	Transistor: germanium, NPN, 2N1304	01295	2N1304	1	
1853-0007	Transistor: SI, PNP, 2N3251	04713	2N3251	2	
1853-0016	Transistor: germanium, 2N3638, PNP	07263	obd#	1	
1854-0005	Transistor: SI, 2N708, PNP	07263	2N708	2	
1854-0011	Transistor: SI, NPN, 2N835	04713	2N835	1	
1854-0033	Transistor: SI, 2N3391, PNP	24446	2N3391	1	

> Option 01
See introduction to this section

Table 7-2. Replaceable Parts (Cont'd)

ℎ𝑝 PART NO.	DESCRIPTION	MFR	MFR PART NO.	TQ	
1901-0025	Diode: silicon, 100 piv	93332	D3072	10	
1901-0026	Diode: silicon, 200 piv	01841	obd#	2	
1901-0028	Diode: silicon, breakdown, 17.8 v ±2%, 400 mw	01841	obd#	2	
1901-0040	Diode: silicon	03877	SG5050	1	
1901-0045	Diode: silicon, 100 piv	86684	34935	2	
1902-0040	Diode: avalanche, 14 v ±5%, 400 mw	04713	SZ10939-224	1	
1902-0045	Diode: avalanche, 7.32 v ±2%, 400 mw	04713	SZ10939-144	1	
1902-0046	Diode: breakdown, 7.15 v ±10%	04713	SZ10939-139	1	
1902-0047	Diode: silicon, 0.5 amp, 400 piv	04713	SZ10939-225	1	
1910-0015	Diode: germanium, 50 ma, 30 piv	98925	CGD1094	1	
1910-0016	Diode: germanium, 100 ma, 0.85 v	11711	GD150	3	
1921-0017	Electron Tube: 7586 nuvistor triode	86684	7586	1	
2100-0128	R: var, comp, lin, 250 ohms ±20%, 1/3 w	28480	2100-0128	1	
2100-0412	R: var, ww, lin, 200 ohms ±20%, 2 w	28480	2100-0412	1	
2100-0721	R: var, ww, 30 ohms ±20%	28480	2100-0721	1	
2100-0805	R: var, ww, lin, 50 ohms ±20%, 2 w	11236	Series 117 Spl.	1	
2110-0004	Fuse: cartridge, 1/4 amp, 250 v	75915	3AG/CAT.312.250	1	
3100-0358	Switch: rotary, 3 sect, 12 pos.	28480	3100-0358	1	
3101-0033	Switch: slide	42190	4633	1	
3101-0036	Switch: toggle, spst, 3 amp, 250 v	88140	8280K16	1	
5000-0703	Cover: side	28480	5000-0703	1	
5000-0711	Cover: bottom	28480	5000-0711	1	
5060-0706	Cover Ass'y: top	28480	5060-0706	1	
5060-0727	Foot Ass'y	28480	5060-0727	1	
5080-5001	Chopper Ass'y: Photoconductor	28480	5080-6001	1	
8120-0078	Power Cord, 7-1/2 ft.	70903	KH4147	1	
9100-0171	Transformer: power	28480	9100-0171	1	
03400-62602	Resistors, matched set	28480	03400-62602	1	
03400-82801	Thermocouples -- matched pair	28480	03400-82801	1	

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Rosella House
Buitencingle Street, Cape Town
Tel: 3-3817

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Centralvagen 28, Solna Centrum
Tel: 08-83.08.30 and 10-83.08.30

SWITZERLAND
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APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 1 of 2)

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humidail Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Company, Ordill Division (Capacitors)	Marion, Ill.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Ind.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co., Electronics Division	Burbank, Calif.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prods., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc., Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04777	Automatic Electric Sales Corp.	Northlake, Ill.
04796	Sequoia Wire & Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P. M. Motor Company	Chicago 44, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp., Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metropolitan Telecommunications Corp., Metro Cap. Division	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co. Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06751	U.S. Semcor Division of Nuclear Corp. of America	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
07115	Corning Glass Works Electronic Components Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Birtcher Corp.	Los Angeles, Calif.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada.
08717	Sloan Company	Burbank, Calif.
08718	Cannon Electric Co., Phoenix Div.	Phoenix, Ariz.
08792	CBS Electronics Semiconductor Operations, Div. of C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atohm Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09664	The Bristol Co.	Waterbury, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	General Instrument Corporation Semiconductor Division	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermolloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14655	Cornell Dubilier Elec. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15909	The Daven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16352	Computer Diode Corp.	Lodi, N.J.
16688	De Jur-Amsco Corporation	Long Island City 1, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Corp.	Hawkesbury, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer and Inst. Co.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
63743	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson & Co., Inc.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas & Betts Co.	Elizabeth 1, N.J.
60741	Tripplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Div. of Daystrom, Inc.	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago 23, Ill.
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Allmetal Screw Prod. Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Electronic Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72092	Eitel-McCullough, Inc.	San Bruno, Calif.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
71707	Coto Coil Co., Inc.	Providence, R.I.
72354	John E. Fast & Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72699	General Instrument Corp., Semiconductor Div.	Newark, N.J.
72758	Girard-Hopkins	Oakland, Calif.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Instruments, Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co, Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	So. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Division of Cinch Mfg. Corp.	Chicago, Ill.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	Micamold Electronic Mfg. Corp.	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Pacific Division of Bendix Corp.	No. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostran Instrument and Electronic Co.	South Pasadena, Calif.
77250	Phoell Mfg. Co.	Chicago, Ill.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	Potter and Brumfield, Div. of American Machine and Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Association. Any brand tube meeting EIA standards	Washington, D.C.
80207	Unimax Switch, Div. of W.L. Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Laboratories, Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Fulton Controls Co.	Columbus 16, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammerlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments, Inc.	New Haven, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co., Inc.	Norwalk, Conn.
81349	Military Specification	....
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.

From: FSC. Handbook Supplements
H4-1 Dated OCTOBER 1963
H4-2 Dated MARCH 1962

APPENDIX
CODE LIST OF MANUFACTURERS (Sheet 2 of 2)

Code No.	Manufacturer	Address
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfg. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Union, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc.	New York, N.Y.
84396	A. J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	Seattle, Wash.
87930	Tower Mfg. Corp.	Providence, R. I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co. Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers, Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Ill.
[illegible]	Tru-Connector Corp.	Peabody, Mass
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith Inc.	Port Monmouth, N. J.
93929	G. V. Controls	Livingston, N. J.
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94222	Southco Div. of S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95023	Philbrick Researches, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Sola Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics Div. of C.B.S., Inc	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Rembrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

Code No.	Manufacturer	Address
C0000	JFD Electronics Corp.	Van Nuys, Calif.
G0000	Tranex Company	Mountain View, Calif.
I0000	Western Devices, Inc.	Inglewood, Calif.
J0000	Winchester Electronics Inc	Santa Monica, Calif.
0000F	Malco Tool and Die	Los Angeles, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000N	Nahm-Bros. Spring Co.	San Leandro, Calif.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000W	Webster Electronics Co. Inc.	New York, N.Y.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000AB	ETA	England
000AC	Indiana General Corp., Elect. Div.	Indiana
000AD	Curtis Instrument Inc.	Mt. Kisco, N.Y.
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Manufacturing Co.	San Jose 27, Calif.
000QQ	Cooltron	Oakland, Calif.
000RR	Radio Industries	Des Plaines, Ill.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000WW	California Eastern Lab.	Burlingame, Calif.
000XX	Methode Electronics, Inc.	Chicago 31, Ill.
000YY	S. K. Smith Co.	Los Angeles 45, Calif.

From FSC Handbook Supplements
H4-1 Dated OCTOBER 1963
H4-2 Dated MARCH 1962

MANUAL BACKDATING CHANGES

MODEL 3400A

RMS VOLTMETER

Manual Serial Prefixed: 401-
hp Part No. 3400A-902

To adapt this manual to instruments with other serial prefixes check for errata below, and make changes shown in tables.

Instrument Serial Prefix	Make Manual Changes
322-	1, 2, 3, 4
401-00617, -00635, -00641, -00652, -00656, -00658, -00659, -00664, 00673 -00683, -00691, and -00693, -00701 below	2, 3, 4

Instrument Serial Prefix	Make Manual Changes
401-01620 and below	3, 4
401-01826 and below	4

CHANGE #1

Table 7-1:

*Change Q601 to hp Part No. 1850-0040, Transistor, GE 2N383 PNP.

Table 7-2:

*Change hp Part No. 1850-0060 to 1850-0040.

CHANGE #2

Table 7-1:

Delete C305.
*Change Q401 and Q402 to hp Part No. 1850-0075, Transistor, GE2N779A PNP.

Table 7-2:

Delete Part No. 0160-0763.
*Change hp Part No. 1853-0007 to 1850-0075.

Figure 6-1:

Delete C305 in parallel with R304; add dashed capacitor in parallel with R301 thru R304 and R306. Add the following information: this capacitance obtained by connecting a wire from R301 and C302 junction to a blank switch lug near R306 and R308 junction.

CHANGE #3

Table 7-1:

*Change T1 to hp Part No. 9100-0171

Table 7-2:

*Change hp Part No. 9100-0344 to 9100-0171.

CHANGE #4

Table 7-1:

*Change Q604 to hp Part No. 1854-0003, Transistor, si, PNP, selected.
*Change Q605 to hp Part No. 1850-0062, Transistor, germanium, PNP, selected.
*Change R8 to hp Part No. 0758-0028, 270 ohms.

Table 7-2:

*Change hp Part No. 1854-0033 to 1854-0003.
*Change hp Part No. 1854-0016 to 1850-0062.
*Change hp Part No. 0686-4315 to 0758-0028.

* Part described in Tables 7-1 and 7-2 is recommended for replacement. Backdating information given for reference only.